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A TIMBER ROT ACCOMPANYING HYMENOCHAETE RUBIGINOSA (SCHRAD.) LÉV.

(WITH PLATES 149–151, CONTAINING 30 FIGURES)

H. P. BROWN

The Hymenomycetes among the fungi play the leading rôle in the disintegration and destruction of wood. Since Theo. Hartig's first attempt at the scientific investigation of the decay of wood in 1833,[8] other workers have contributed from time to time and as a result an extensive literature on this phase of mycology has been gradually collected.

Of the investigated forms, the Polyporaceae have been most extensively studied. This is due in part at least to their large, conspicious fruit bodies and the obvious relation between them and the decay resulting in the wood. Many other Basidiomycetes as well as Ascomycetes are wood-inhabiting, and interesting results have already been obtained from studies of isolated forms in various families. The field of research may be divided into two lines of effort; to secure definite data on the chemical composition of wood in general and of changes resulting from decay, and to augment our present field of knowledge of the decay of wood by a study of uninvestigated wood-inhabiting forms. The present study of *Hymenochaete rubiginosa* (Schrad.) Lév. was undertaken with the latter point in mind.[1]

[1] This work was carried on in the Botanical Laboratory of Cornell University under the direction of Prof. Geo. F. Atkinson, to whom the writer is indebted for the suggestion of the problem and for advice.

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Hymenochaete rubiginosa is a common saprophyte on decorticated chestnut in the vicinity of Ithaca, N. Y., and is also found more rarely on decorticated oak. The brown, resupinate or dimidiate fruit bodies (Figs. 1, 3), rarely over four or five centimeters in diameter, are usually to be found where oak and chestnut timber lies on the ground in the forest. Chestnut-rail fences which extend into the deep shade of the woods present an ideal place for its collection and almost invariably the lowest rail, partially immersed in leaf-mold, is infested with the fungus. Where the rail is oblique to the surface of the ground and one end is imbedded in the humus, thereby insuring a sufficient supply of moisture, the fruit bodies may be entirely resupinate and reflexed. On fallen trunks they usually become dimidiate and often hollow-ungulate, the pilei imbricated, irregularly united and sharply oblique to the substratum. When mature, the shelving pilei are smooth above, except for the pubescent margin, and exhibit fine concentric lines on their upper surface. These are not the result of perennial growth, since the fruit bodies are annual, but rather of fluctuations in seasonal growth brought about by varying amounts of moisture. The fruiting surface, or hymenium, of the pilei is glabrous at maturity except at the margin. When viewed with a pocket lens of ten diameters, it is seen to be covered with many brown setae which project upward from the grayish hymenium. It is due to this character that Léveillé[10] first separated such forms from the genus *Stereum*.

Development of the Fruit Bodies.—As already noted, the fruit bodies make their appearance on decorticated wood. Even in collecting several hundred specimens at periods extending over two years, no exceptions were found to the above rule. The fruit bodies rarely appear on wood in an advanced stage of disintegration. A few cases were observed where the wood was badly decayed to a depth of a centimeter under the fruit bodies due to attacks of this or other fungi. In such cases, however, the fruit bodies were always connected with the firm, hard wood in the core of the log. They are never formed from mycelium in wood which has lost its firmness or exhibits advanced stages of decay.

The first evidence of the formation of fruit bodies is the appearance of small, brown, mycelial wefts on the surface of the

infected wood. These are usually discoid in shape and about the size of the head of a pin. More rarely, narrower brown areas occur which are elongated lengthwise of the log. In such cases the hyphal wefts arise from seasoning checks in the wood; the first case is by far the most frequent. Usually several, or as many as a dozen, of these small brown disks arise in the area of a square inch.

The manner of growth of the brown disks, once formed, depends on their position with reference to the substratum. If they occur laterally on a log, dimidiate fruit bodies are formed; if on the under side, wholly resupinate forms arise. In either case, growth goes on all along the margin of the disk for a time. Subsequently, in the dimidiate forms, the upper margin continues its growth, arches out away from the substratum, and forms the pileus. The lower margin continues to expand for a short time downward along the substratum and may unite with other fruit bodies, but eventually, and much sooner than the arching upper margin, ceases to grow. The final result is a cluster of shelving fruit bodies, partially coalesced behind next to the substratum, but with separate free outer margins.

The development of the wholly resupinate forms is easier to follow. Growth is much more regular along the margin and may continue so evenly that circular fruit bodies are formed. Usually, however, owing to the irregularities of the substratum, growth is restricted here and there so that the contour of the fruit bodies becomes irregular and sinuous. This appearance is still further enhanced because the fruit bodies often coalesce (Fig. 21). Two advancing margins meet and the hyphae intermingle. The line of union remains distinct for a time as a pubescent ridge through the hymenium, but eventually the latter covers this and the line of delimitation between the two fruit bodies is obliterated. In this way, extended hymenial layers are formed in the resupinate type. Evidence of their synthetic origin may be observed, however, by carefully removing them from the substratum and examining the surface next to the wood. In such a case, one finds as many points of attachment as there are units entering into the structure of the compound sporophore.

Age of Fruit Bodies.—The fruit bodies of *Hymenochaete rub-*

iginosa are annual. Growth may go on at the margin until well into the autumn and as a result an increase in surface area occurs. but in no case was a new hymenial formation found the following spring. After the first season, the hymenial surface loses its rich rubiginous color and becomes dull and grayish-brown. As the fungus dries out, as happens in many cases, extensive checking occurs. The fruit bodies of the season are readily discernable from those of former years because of the differences enumerated above.

The fungus is essentially a xerophyte. It withstands to a remarkable degree the many vicissitudes of climate and recovers well after a prolonged drought. Within a few hours after precipitation, spore formation begins again and continues as long as favorable conditions prevail. Interrupted spore formation may go on in this way during the summer and autumn.

The time at which fruit bodies first begin to shed spores varies with conditions. Fruit bodies with a surface area of a square centimeter were found to be producing viable spores, and it is possible that spore formation may have begun when they were much smaller. Spore formation begins before the fruit bodies have attained their ultimate size and continues with many interruptions until late autumn.

Structure of the Fruit Bodies.—There are three distinct layers discernable (Fig. 18), which give to the fruit body a stratose structure. The lower exposed layer bears the hymenium on its outer surface and makes up the greater part of the thickness of the fruit body (Fig. 4) and its limits of variation are such that a fruit body may be fully twice as thick in some places as in others. The second layer consists of a narrow stratum of hyphae near the upper surface, closely entwined and fastened together. The third and last is a loose, floccose stratum of hyphae, in which the course of the filaments as individuals may be readily followed. The last two layers exhibit little variation in thickness.

The hymenium of the species under consideration (Fig. 19) consists of three distinct structures, viz.: large and prominent brown cystidia (*a*), colorless basidia (*b*), and a third element similar to the basidia, but shorter and only slightly enlarged at the tip (*c*). These may be immature basidia which subsequently

elongate and produce spores. This conclusion is plausible because spore formation continues for a long period and careful examination of fruit bodies during the summer and autumn has shown that the spores produced by a basidium mature at approximately the same time.[2] It follows that the basidia probably develop successively during moist periods, a condition which accounts for the continued spore formation.

The large, brown setae vary in shape from conical-acute to bluntly cylindrical and measure 70–100 μ by 4–5 μ. Below, they taper gradually into thin-walled hyphae which extend horizontally. Massee[11] makes note that in addition to the normal setae, stout cylindrical, obtuse, thin-walled, pale-brown bodies, intermediate between setae and cystidia, are sparingly met with in the hymenium. A careful microscopical examination of a number of specimens failed to reveal such structures in the form common about Ithaca, N. Y.

The basidia are approximately one third the length of the cystidia and are quite colorless. They are attached below to brown hyphae.

The spores are hyaline, ellipsoidal, and measure 5.5–6.4 μ long by 2.8–3 μ broad (Figs. 2, 17[a]). These dimensions conform closely to the spore measurements by Massee, who gives them as 5×3 μ for this species. Saccardo[14] in his description says "sporis cylindraceis, curvatis, 5–6 μ long." The spores of specimens found about Ithaca correspond in length, but are neither cylindrical nor curved. Spores taken from a number of fruit bodies all proved to be ellipsoidal.

Spore Germination.—Spores were obtained from many different specimens through a period of two years. The fruit bodies as brought in from the field were placed in moist chambers over sterilized petrie dishes, and the spores obtained in this way were preserved for further study.

Spore germination was attempted in Van Tieghem cells which had been carefully sterilized previously with 5 per cent. corrosive sublimate solution and rinsed in distilled water. Mounts were then made, using tap water, distilled water, filtered chestnut

[2] H. M. Ward[18] has described and figured similar structures in the hymenium of *Stereum hirsutum* Fr. and has suggested further that these intermediate hyphae may grow forward to develop a new hymenial layer.

wood extract, prune decoction and a solution of beef extract and malt.[3] The best germination was obtained with chestnut wood extract. Slight germination occurred in tap water and in the malt beef extract; the others gave negative results.

Before germination, or with its inception, the spore becomes vacuolate (Figs *b* and *c*). Then germination occurs at one or both ends. Lateral germ tubes were not observed. A small papilla, always of smaller diameter than the spore, is formed, which gradually elongates to form the germ tube. At the end of forty-eight hours, some of the germ tubes attained a length of from four to six times the length of the spore (Fig. 8). Thereafter growth was very slight. In preparations a week old, here and there a germ tube had branched, but in general only slight elongation occurred after the second or third day. Mycelial wefts were not obtained in hanging drop cultures. Rarely one or two cross walls were formed in the germ tube, but these were never accompanied by clamp connections.

An earnest effort to secure pure cultures of the fungus led to no tangible results. Various media were tried, among which may be enumerated prune agar, bean agar, chestnut wood decoction agar, chestnut wood decoction gelatin, corn meal moistened with wood decoction, corn meal moistened with tap water, sterilized chestnut wood, sterilized oak wood, bean tubes, potato tubes, carrot tubes, and a medium made after Marpmann's formula.[4] Inoculations were made with newly fallen spores and with germinating spores from hanging drop cultures. A sparse, floccose mycelium from germinating spore infection was formed in the bean tubes, but the hyphae were always restricted in their growth. Attempts to transfer these colonies to more favorable media resulted in failure. New experiments are now under way with this object in view, and it is to be hoped that they may be more fruitful of results. The timber rot accompanying the fruit bodies

[3] 2½ gm. Liebig's beef extract[13], 2½ gm. Loffiund's malt extract, 100 c.c. water.

[4] Dissolve by cooking 10 gm. of gelatin and 10 gm. of agar in 500 gm. of beef extract; then add to the solution 10 gm. glycerine, 10 gm. salt, 5 gm. ammonium phosphate, and 4 gm. potassium nitrate; filter.

of this fungus on chestnut and oak, compared with the condition of the normal wood, may now be described.[5]

Character of Normal Wood.—The wood of chestnut is of the ring-porous type.[12] There are several rows of large vessels in the spring wood out of which branching rows of smaller vessels extend radially into the summer wood. The transition from large to small vessels is usually very abrupt (Fig. 6) and the radial arrangement of the small vessels is often somewhat obscure. Annual ring formation is pronounced, each ring being sharply delimited from the others. The width of the ring varies within wide limits; sometimes in coppice growth it is over half an inch in thickness. The pith rays are minute and scarcely distinguishable with the naked eye.

Miscroscopically the wood of chestnut is seen to consist of (*a*) uniseriate pith rays, (*b*) pitted vessels, (*c*) metatracheal parenchyma with simple or semi-bordered pits, (*d*) tracheids and (*e*), wood fibers. The last are not typical fibers, but of the nature of fibrous tracheids.[6] The vessels are discernible in cross section by their size. Fibrous tracheids, tracheids, and wood parenchyma look much alike; the last may be distinguished, however, through its protoplasmic contents. The vessels exhibit the greatest variation in size in the annual ring. The cell lumina of the parenchyma and prosenchyma are somewhat wider in the spring wood than in the summer wood, but show no great range of variability in actual size.

Description of Decay in Chestnut.—The first evidence of incipient decay in chestnut wood is the appearance in the wood of irregular areas in which the tissues have lost their natural brown coloration and become grayish-white (Fig. 5, 10). These areas are 1 mm. or less in cross diameter by 5–25 mm. in longitudinal direction. The wood between the lighter areas remains as sound

[5] Direct evidence of the causal connection of *Hymenochaete rubiginosa* with the peculiar rot which accompanies it, has not been obtained in the present study. It is reasonable to assume that the rot in question is caused by this species since it always accompanies this form on chestnut. Further, the same type of rot is associated with this fungus on oak. This evidence, though not conclusive, leads to the inference that this peculiar decay of oak and chestnut is caused by *H. rubiginosa*.

[6] In length and taper, fibrous tracheids resemble fibers; in width and bordered pits, tracheids.

apparently as ever.[7] Logs, limbs an inch or more in diameter, rail fences, chestnut posts and structural chestnut timber may be attacked. The infection at the start is a local one, and the diseased areas first occur in the last few rings. In such cases they are next to the ground, or with large logs on the lateral side most protected from drought. Only in an advanced stage is the whole cross section attacked, and before this condition is reached the inroads of the fungus are usually arrested through lack of moisture. Chestnut is very durable in contact with the soil, and it is not uncommon to find fallen decorticated limbs and branches showing the decay described above on the lower side, while they are as sound at the core and on the upper side as normally. Only where sufficient moisture is available is the center of the log attacked. Cracks due to checking and frost action greatly facilitate the action of the fungus, since they permit the ready ingress of water into the deeper-lying tissues (Fig. 28).

All parts of the annual ring are susceptible to the attacks of the fungus (Fig. 14). The white areas of varying extent and irregular outline may include within their boundaries one or more vessels in the spring wood, or be entirely confined to the outer portion of the ring. The last is usually most severely attacked, however. Occasionally infected spots coalesce and form large areas, although they usually remain free from the start.

At first there is no disintegration in the wood other than the formation of the irregular white areas. The elements retain their original size, thickness, and continuity with one another. Subsequently near the center of the white areas a small cavity appears (Fig. 6). This is bounded at first by white tissue on all sides and includes but a small portion of the diseased area. The white tissue at the margin remains undisturbed.

Within the cavity itself, disintegration is not complete. It is filled with long, white, fibrous elements which remain loosely attached or entirely free from one another. These are thick-walled and offer great resistance to the dissolving action of the fungus. The cavities gradually enlarge as the disintegration goes on until finally all that remains of the original white area is a narrow

[7] The whole mass of tissue is never affected as in the case of some forms 12, 16, and the wood never loses completely its firmness and elasticity.

boundary line about an enlarged cavity filled with isolated or loosely bound white fibers (Fig. 12). The wood between the cavities retains its original color and is, to all appearances, as sound as ever. In age the white contents and lining of the pockets may disappear and the wood presents the appearance of Figure 9.[8]

In order to trace the progress of the decay in the wood, the following methods were employed. Diseased wood was cut into blocks of convenient size, which were then boiled to fix the hyphae. The air remaining in the tissues was exhausted with an air pump and the blocks were finally imbedded in celloidin in the usual manner. Sections 10 microns thin were used.[9]

A microscopical examination of the wood reveals the action of the fungus to better advantage. In the infected areas the

[8] Another type of decay was observed in the wood near the surface of the logs which exhibited in the deeper-lying tissues the characteristic decay already described. For a distance of several millimeters inward from the surface, the tissue had turned dark-brownish-black. Whether this decay was caused by the same fungus as that in the deeper-lying tissues was not determined. A species of *Dasycypha* was frequently found accompanying the Hymenochaete and this may have been responsible for the second type of decay.

[9] In preparing sections for microscopic study both temporary and permanent mounts were made. The first were employed to observe through michrochemical reactions the chemical changes in the wood brought about by the fungus. Among the lignin tests which were used may be enumerated the HCl-phloroglucin reaction, the $KClO_3$-HCl-phenol reaction, aniline sulphate and H_2SO_4, and thallium sulphate in equal mixtures of water and alcohol.[19] The cellulose tests included chlor-zinc-iodide, sulphuric acid, I-KI and iodine followed by sulphuric acid.

The sections used for permanent mounts were stained in several different ways, viz.: Delafield's haematoxylin and aniline safranin, Haidenhain's haematoxylin and safranin, Haidenhain's haematoxylin and methyl green, 20 per cent. aq. tannic acid and methyl violet, ruthenium red and methyl green. The last two stains enumerated gave the best results with the preference in favor of the methyl violet.

In staining with methyl violet, the material was first treated with a twenty per cent. aqueous solution of tannic acid for twelve hours. It was then quickly rinsed with water and transferred directly to a one per cent. solution of methyl violet for three minutes. The excess stain was removed with 95 per cent. alcohol and the material was finally cleared in clove oil. Only the hyphae in the tissues retained the stain.

The method pursued with ruthenium red and methyl violet was that recommended by Eisen[4]. It has also been described in a recent paper by Learn[9] and does not require further explanation here because no deviations were made from the prescribed formula.

hyphae run vertically in the cell lumina and are closely applied to the tertiary wall. In cross section (Figs. 22 and 26) they appear as small black dots within the cell cavity. Viewed in longitudinal section each element is seen to contain from several to many hyphae which extend vertically from cell to cell and penetrate the walls at will. Preference is shown for the pits on the walls as in the case of some other forms (Figs. 27 and 29), but the avenues of penetration are by no means restricted to the pits. The hyphae pass directly through the wall with little or no constriction (Fig. 23). Subsequently the perforations thus arising are further enlarged through enzyme action so that the hyphae appear to pass through openings much too large for them. In an advanced stage of decay only the openings are left as the hyphae disappear (Figs. 25 and 30). Nests of hyphae also accumulate in vessel cavities, but the centers of infection are usually in areas where only parenchyma and fibrous tracheids occur. Where pith rays cross the diseased areas, they are attacked and eventually destroyed.

Chemical Changes in Chestnut Wood.—The first chemical change which is brought about by the fungus is that of delignification. It is due to this action that the elements lose their normal brown color and become white. The fungus probably secretes dissolving enzymes which attack the tertiary layers first and work outward. The compounds which are known collectively as lignin are entirely dissolved and walls of pure cellulose left behind. Near the center of infected areas all stages in the process of delignification are to be found (Fig. 26). In the sound cells just without the diseased tissue, all three cell layers respond to tests for lignin (Fig. 22 *c*), although the tertiary layer appears to be less strongly lignified than the others. The elements nearer the center of infection are already partially delignified (*b*). In some the tertiary layer no longer gives the lignin reaction, or but feebly, while in others the secondary and primary layers have become involved and delignified. The lignin reaction persists longest at the cell corners where the wall is thickest, or about the small intercellular spaces which often occur there, but even here it disappears eventually, and the tissue that remains consists of almost pure cellulose.

As soon as the middle lamella is delignified, the cells separate

from one another (Fig. 26 *c*). Whether the middle lamella dissolves or splits is difficult to decide, but it would appear that the former is the case, in that ruthenium red failed to reveal any trace of the middle lamella where the elements had separated. No eroding action of the fungus is to be noted at this stage. The infected area is filled with a mass of white cells, in part free from one another, or loosely joined at the corners where the middle lamella has persisted.

Before the changes above enumerated have taken place in all the outer cells of the infected areas, further alterations usually occur in the elements first infected. The cellulose walls now undergo digestion (Fig. 11), probably in the usual way through the secretion of cytolytic enzymes.[10] The vessels, parenchyma cells and pith ray cells together with the thin-walled prosenchyma are almost entirely dissolved (Fig. 20). The thicker-walled prosenchyma persists the longest, and after the other elements have disappeared remains as a white fibrous structure partially filling and lining the cavities that have arisen. The abundance of these fibers depends in a large part upon the cytolytic activities of the fungus. The dissolving action may go on in extreme cases until the pockets are quite empty of contents, but usually, for reasons which cannot be satisfactorily explained, the activities of the fungus are inhibited before this condition is reached.

The conditions met with in the dark-brown peripheral tissue, previously described, are quite different from those enumerated above. All the cells here have been attacked and partly digested (Fig. 7). Many hyphae are to be seen in vertical view closely applied to the cell walls and the latter fail to respond to either the phloroglucin-HCl or the chlor-zinc-iodide reaction. R. Hartig[7] noted the same condition in his study of *Merulius lacrymans*. It is possibly explained on the supposition that the fungus has dissolved out but a part of the lignin, and that the portion remaining conceals the chlor-zinc-iodide reaction for cellulose. The periph-

[10] Czapek[3] considers lignified walls as made up of a hadromal-cellulose ester. The attacking fungus may secrete two or more enzymes, among which may be included hadromase and cytase. The first splits off the compound ester and removes the hadromal. The cellulose remaining behind is subsequently dissolved by the cytase.

eral decay is always restricted, however, and does not seem to be important.

Condition of the Wood Between the Pockets.—As previously noted, the wood between the infected areas remains unaltered chemically and still responds to the various lignin tests. Here and there in a cross section a fungal filament may be seen extending from cell to cell, but the tissue is usually quite free of ramifying hyphae. In general, delignification occurs only in those tissues where the hyphae extend vertically.

It is obvious that mycelial connection exists between the pockets in the wood. This is brought about in some cases by isolated hyphae which extend horizontally through the tissues. More commonly, however, connecting strands of mycelium (Fig. 24) are formed for this purpose. These, as noted in the figure, consist of a number of filaments closely intertwined and forming a horizontal bridge between the pockets. The strands thus arising extend both radially and tangentially. They cause no chemical alteration in the wood other than that correlated with their penetration, but appear to be a means of spreading the areas of infection horizontally.

Character of Normal Oak Wood.—While closely related botanically to chestnut, oak departs decidedly from the former in the anatomy of its wood. Both possess ring-porous wood with rows of smaller vessels which branch in the outer portion of the ring. The transition from large to small vessels may or may not be decidedly abrupt.[11] Annual ring formation is as pronounced as in chestnut. The chief difference between the two woods consists in the presence of large multiseriate pith rays (Fig. 16) in oak wood accompanying the smaller uniseriate rays. Contrasting the two genera, oak has two kinds of pith rays, chestnut one.

When examined microscopically, the wood of oak is found to consist of the same elements as those of chestnut. There are several anatomical differences worth noting, however. The vessels have thicker walls. The parenchyma in oak is more abundant and makes up a greater proportion of the wood. There is an abrupt transition from tracheids to wood fibers, and fibrous tracheids do not occur. The tracheids possess bordered pits; the

[11] Abrupt in white oak, gradual in live oaks and red oaks.

fibers narrow, oblique, simple pits.[12] This is in strong contrast to the chestnut where all gradations between tracheids and fibers occur, and the latter are characterized by bordered pits of the usual type. Further, the fibers in oak have thicker walls and are more strongly lignified.

In tangential section (Fig. 13) the two types of pith rays are easily discernible. The multiseriate rays appear as broad fusiform structures extending for several millimeters in a vertical direction, while interspersed between them and far surpassing them in number, are the small uniseriate rays. The latter are shorter than those in chestnut.

Description of the Decay in Oak.—The decay of oak associated with *Hymenochaete rubiginosa* is similar to that of chestnut. White areas of varying extent and irregular outline are formed (Figs. 13, 16 *a*), which extend a millimeter or less across the grain, but often a centimeter or more longitudinally. These subsequently give rise to cavities or pockets lined and partially occluded with white fibers. After this stage further disintegration ceases and the wood appears sound except for the presence of many pockets scattered quite regularly through it. The wood of chestnut and oak never becomes soft and badly disintegrated in this type of decay, but the fungus exhibits a remarkable similarity of action on these two hosts.

The effect of the mycelium of *Hymenochaete rubiginosa* on the wood of chestnut and oak is comparable in its grosser aspects to that of *Trametes abietis* Karst. on the red spruce,[1] and the "partridge" wood of oak caused by *Stereum frustulosum* (Pers.) Fr.[13]. In each case the areas of disintegration are at first localized. The elements of the wood within the infected areas are wholly or in part dissolved and cavities arise which are lined with a layer of almost pure cellulose, and remains of delignified elements.[14] In

[12] It is held by some that all prosenchyma is equipped with bordered pits. The "so called" oblique simple pits in the fibers are interpreted as flattened bordered pits which have been spirally stretched.

[13] Described by R. Hartig[6] as *Telephora perdix*.

[14] Weir[18] has recently published a description of a new fungus, *Fomes putearius* Weir, in which the decay is similar to that of *T. Pini* Fr. The lignin reduction, however, is on a much larger scale and the cellulose pockets are frequently two inches in length and vary in breadth according to the structure of the host.

the case of *Trametes abietis* the wood between the original areas of infection is finally attacked and broken down so that the whole mass of wood tissue eventually loses its firmness and is in large part destroyed. The same does not apply to the other fungi mentioned since the cells remain intact and sound between the diseased areas so far as can be detected by microchemical reactions.

The similarity between *Stereum frustulosum* and *Hymenochaete rubiginosa* in their manner of attack and effect on the wood is striking. Both are xerophytic fungi and attack decorticated wood which is sound or little decayed through the attacks of other fungi. The first is a perennial form reported on oak alone, so far as I have observed, the second an annual form found on oak, chestnut, and several other hosts. The first evidence of attack in both is in the formation of white areas which respond to the tests for cellulose. Subsequently the elements in these are in part digested and cavities are formed which in one stage of the disease are lined with a white layer of cellulose. The wood remains sound between the diseased areas and in the final stage the condition resulting is comparable to a honeycomb in which the cavities of the wood represent the chambers in the comb, and the tissue lying between, the walls of the chambers. The white lining has entirely disappeared at this stage.

From the preceding paragraph it follows that the decay in oak associated with *H. rubiginosa* is very similar, superficially, to that caused by *Stereum frustulosum*. Closer examination of the specimens at hand, however, has revealed a difference which may be of value in separating these two types of rot. The flecks caused by *Stereum frustulosum* are shorter and wider than those associated with *H. rubiginosa*. In radial view they appear as a rule from oval to elliptical in shape, while those of *H. rubiginosa* are narrow elliptical to long cylindrical. In the final stage of *Stereum frustulosum* the wood is much more porous, due to the large size of the cavities and the small spaces intervening.[15]

Chemical Changes in Oak Wood.—What has been said regard-

[15] The differences given above are much a matter of degree, however, and familiarity with the two types of decay is essential in making a reliable diagnosis.

ing the method of attack and chemical changes in the wood for chestnut applies equally well for oak. The first visible evidence of attack is the formation of white areas in the tissue due to the delignification of the elements. The centers of infection lie between the broad pith rays. In the white spots the hyphae run vertically and become closely applied to the walls of the cells. The fungus works from the lumen outwards, and first removes the lignin from the cell walls, leaving pure cellulose behind. As soon as the middle lamella is attacked, the cells separate completely or cling together loosely at the corners where the thicker walls offer more resistance to the fungus. Finally the thin-walled parenchyma cells and the tracheids are entirely dissolved. The thick-walled strongly lignified wood fibers persist the longest. Only a part of them are dissolved, the remainder forming a white cellulose lining and partly filling the cavities (Fig. 15). In the final stage the cellulose lining is entirely lacking.[16]

The wood between the infected areas, as in chestnut, remains apparently as sound as ever. Here and there a hypha may be seen extending horizontally from cell to cell, but connection between the pockets is secured mainly, as in chestnut, by strands of mycelium which run radially and tangentially. As previously noted, the centers of infection have their origin between the large medullary rays, while in chestnut they may occur anywhere within the ring. Once started, however, the white areas spread and may include a portion of a compound ray within their boundaries. The decay in oak is comparable to that in chestnut except in minor respects.

The remarkable similarity which has been shown to exist superficially between the decay of oak caused by *S. frustulosum* and that of *H. rubiginosa* is even more striking when a microscopical investigation is made. The walls of the infected elements in both cases are first delignified, beginning with the tertiary layer, and pure cellulose left behind. As soon as the primary layer is reached, it is dissolved and the elements separate. Subsequently cellulose digestion goes on and the thinner-walled elements are entirely dissolved, the thicker-walled fibers disappearing last and appearing for a time as a white layer lining the cavities.

[16] What has been said above concerning the restricted peripheral decay in chestnut applies equally well to oak.

It is of interest in this connection to compare *Stereum hirsutum* Fr. with *Hymenochaete rubiginosa* in its method of attack on wood and the chemical changes involved (Ward, 1898). This form is not so exacting as to its host as *H. rubiginosa*, but grows readily on oak, willow, horse-chestnut, pine, and other hosts. The fungus, while usually saprophytic, may spread from dead wood into the trunk and in such cases shows marked preference for the sap wood. This does not apply with *H. rubiginosa;* it is found uniformly on fallen, decorticated wood and no preference is shown for sap wood. The mycelium of *Stereum hirsutum* attacks all the elements in the diseased tissue with equal ease and localized areas of distintegration are not formed. The whole mass of tissue eventually succumbs and a general decay of the wood results. In both fungi the first evidence of decay is one of delignification. The tertiary layers are first reduced to cellulose, followed successively by the secondary and primary layers, and the swollen cellulose matrix is then consumed, layer by layer. In the case of *S. hirsutum,* the primary lamella is not attacked until the last, and before it succumbs the tertiary and secondary layers have usually entirely disappeared. This is in marked contrast to the decay caused by *H. rubiginosa,* where the middle lamella disappears as soon as lignin reduction is complete and before cellulose digestion has taken place. While closely related botanically, marked differences occur in the decay caused by the two forms.

The superficial type of decay at the periphery of the wood noted above has likewise been observed in connection with *Stereum frustulosum.*[17] The possibility still remains, however, that this may have been caused by the mycelium of another fungus as in the case of the form described in this paper. Pure cultures are necessary to decide this point.

Between the cavities the wood appears sound in both forms of decay. The pockets may enlarge occasionally and coalesce, and larger pockets thus arise. The mycelial strands accompanying the decay described here were likewise described by Hartig in connection with *Stereum frustulosum.* Both forms apparently employ the same method of attack and bring about a similar progress of decay in the wood.

[17] Hartig, Th., loc. cit., page 19.

SUMMARY

1. *Hymenochaete rubiginosa* (Schrad.) Lév. is a common saprophyte on decorticated chestnut about Ithaca; it is found more rarely on oak.

2. The fruit bodies are annual and quite xerophytic; spores are shed intermittently during moist periods for several months.

3. Spore germination occurs best in decoctions of oak or chestnut sawdust and tap water. Mycelial growth was restricted and clamp connections were not observed.

4. The first evidence of decay in oak and chestnut consists in the formation of white spots here and there in the wood. Cavities lined with cellulose are formed through the partial or complete digestion of the elements.

5. The tissues between the infected areas remain nearly or quite as sound as in normal wood. Rarely do the pockets coalesce through the digestion of intervening tissue.

6. The chemical action of the fungus consists first in the delignification of the elements attacked. This begins with the tertiary layer and continues outward.

7. Soon after the middle lamella is attacked it is dissolved and the elements separate or remain loosely attached at the corners.

8. Cellulose digestion continues after the elements become isolated. The thin-walled elements including pith ray cells and wood parenchyma are first dissolved.

9. The pockets arising in the wood are at first lined with partially digested elements which consist of pure cellulose. In the final stage the white lining entirely disappears.

10. The decay accompanying the fungus is comparable to that caused by *Trametes abietis* Karst., on red spruce and other conifers. It has a remarkable resemblance in superficial appearance and method of attack to that caused by *Stereum frustulosum* (Pers.) Fr.

11. A superficial, peripheral type of decay, in which all the elements are attacked but not entirely digested, usually accompanies the typical decay caused by *Hymenochaete rubiginosa*. The walls remaining are dark in color and fail to respond to the cellulose reaction.

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EXPLANATION OF PLATES CXLIX–CLI

Plate CXLIX

Fig. 1. Dimidiate fruit bodies of *Hymenochaete rubiginosa* (Schrad.) Lév. on a chestnut log. × 1/9.

Fig. 2. Ellipsoidal spores of *Hymenochaete rubiginosa.*

Fig. 3. Resupinate fruit bodies on a chestnut log. × $\frac{2}{3}$.

Fig. 4. Section of fruit body, hymenial surface above.

Fig. 5. Cross section of small chestnut log showing white areas characteristic of one stage of decay. × 8/9.

Fig. 6. Portion of the same enlarged; cavities in process of formation.

Fig. 7. Appearance of tissue in the peripheral type of decay; the hyphae are closely appressed to the cell walls and all the cells are undergoing disintegration.

Fig. 8. Germinating spores in hanging drop culture; note vacuolation in the germ tubes.

Plate CL

Fig. 9. Cross section of small chestnut log showing final stage of decay. × $\frac{2}{3}$. The contents of the pockets have entirely disappeared.

Fig. 10. Tangential view of pockets. × $\frac{2}{3}$. The white cellulose contents have not been dissolved.

Fig. 11. Tissue at the edge of a diseased area. Note (*a*) the delignification of the elements, (*b*) the separation due to the disappearance of the middle lamella, and (*c*) final digestion.

Fig. 12. Cross section of chestnut wood showing scattered, irregular-shaped areas where disintegration has occurred. The wood between the pockets is still sound.

Fig. 13. Tangential section of oak wood showing shape of the pockets in side view.

Fig. 14. Cross section of chestnut wood showing a portion of diseased tissue which includes one vessel.

Fig. 15. Same as figure 13. Note the partially digested, thick-walled prosenchymatous elements projecting into the cavity.

Fig. 16. Cross section of oak wood; diseased area on the extreme right (the hazy appearance in the center of the figure is not due to the attacks of the fungus).

Plate CLI

Figures 17–20 are photographs of pen drawings.

Fig. 17. Spores, germination, and germ tubes forty-eight hours after germination.

Fig. 18. Cross section of a fruit body; hymenium above.

Fig. 19. Portion of hymenium enlarged showing cystidia, basidia and spores, and immature basidia.

Fig. 20. Cross section of chestnut wood at margin of diseased area, showing sound cells at *a*, partly delignified cell at *b*, and partly digested cells at *c*.

Fig. 21. Young fruit bodies coalescing to form extensive hymenial surfaces.

Fig. 22. Cross section of chestnut wood at margin of a pocket. The shading indicates the extent of delignification in the cell walls.

Fig. 23. Wood parenchyma cells of chestnut in longitudinal view; hyphae extending horizontally through the pits.

Fig. 24. Mycelial strand extending through the tissue. These serve to connect the pockets which are subsequently formed.

Fig. 25. Pith ray and neighboring parenchyma cells in tangential view. Hyphae have passed through the pits, eroded the cell wall, and then disappeared, leaving irregular openings.

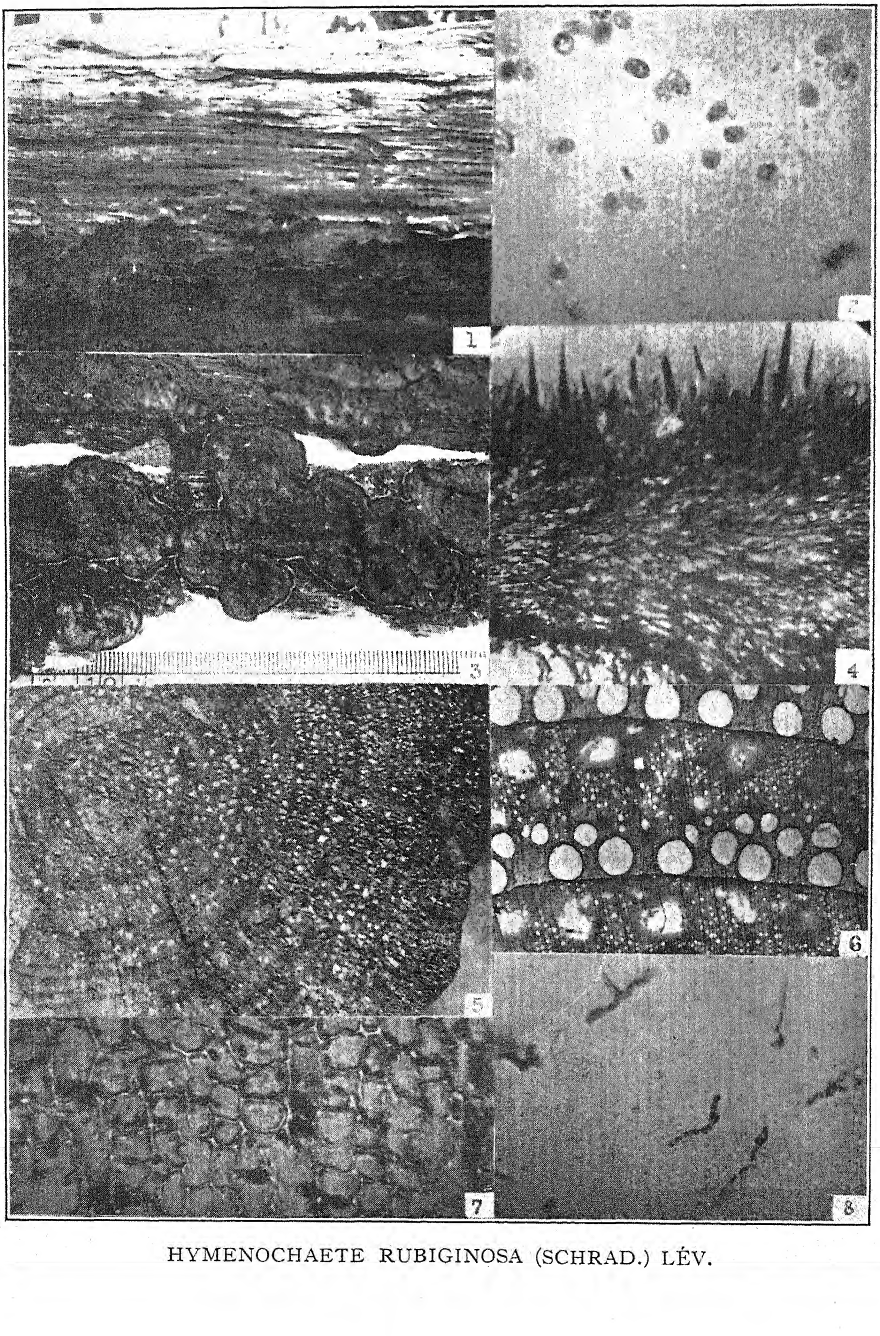
Fig. 26. Cross section of "pocket" in process of formation. The cells have been delignified and have separated from one another.

Fig. 27. Radial view of a pith ray (with other elements in the back-ground) showing the course of hyphae through the wood. Penetration of the wall occurs mainly through the pits.

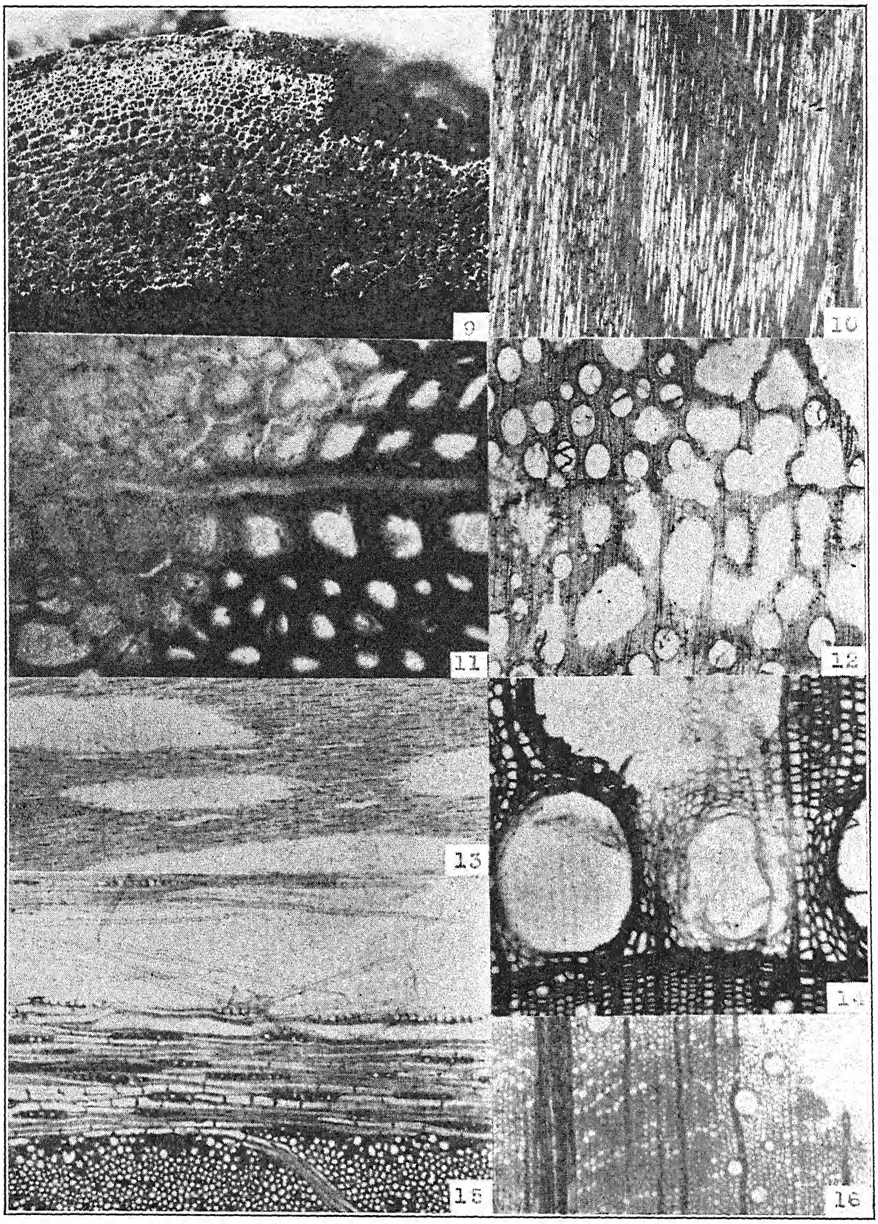
Fig. 28. Cross section of chestnut log showing seasoning check. The fungus tends to follow these checks into the deeper-lying tissues.

Fig. 29. Radial section of chestnut wood showing fungus filament passing through bordered pits of prosenchyma.

Fig. 30. Portion of pith ray and parenchyma cells of chestnut, tangential section. The intercellular space at (*a*) and the pits at (*b*) have been enlarged through fungal attack.



HYMENOCHAETE RUBIGINOSA (SCHRAD.) LÉV.



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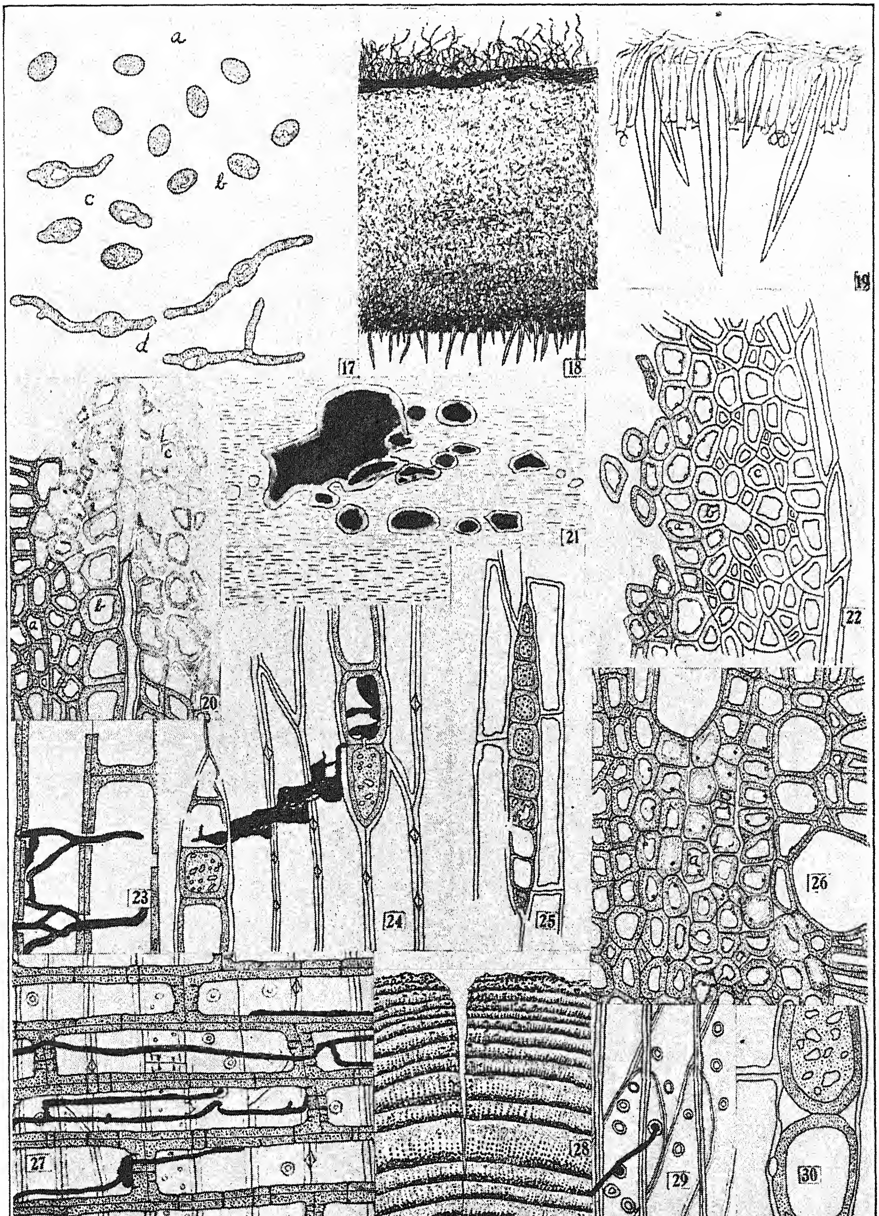


HYMENOCHAETE RUBIGINOSA (SCHRAD.) LÉV.

STRUCTURAL PARALLELISM BETWEEN SPORE-FORMS IN THE ASCOMYCETES[1]

C. R. Orton

(With Plate 152, Containing 7 Figures)

The term "structural parallelism" is here substituted for the word "homology" which was used when the paper was first presented. There was some objection to the use of the word *homology* and with good reason, for although Brefeld appears to have used the word in a somewhat similar manner, the general use of this conception has been, especially in zoology, not a structural or functional resemblance but a phylogenetic similarity of origin. The similarity which the writer wished to bring out in this paper might be more nearly expressed by the word *analogy* but this implies a functional similarity which, although it may be present, is not precisely what is in mind.

The term *physiological parallelism* was suggested as the general one used to describe similarities like those enumerated in this paper. It seems, however, that even this expression is not strictly appropriate, for the word physiological implies again a functional relationship.

The relationship which the writer has in mind is one of a purely structural nature between ascospores and conidia in certain species of Ascomycetes, though similarity in color often accompanies it. Considering the subject purely from this standpoint, the term *structural parallelism* would seem to fit more closely the phenomenon which the writer desires to express in this paper. This appears to be the first time that a study has brought facts of this sort together for this class of fungi, although such a relation undoubtedly has been observed by other investigators.

We are indebted to Tulasne for the early researches among the

1 Read before the Botanical Society of America at the Atlanta Meeting, December 31, 1913. (Abstract. Science 39: 258. 1914.) Contribution from The Department of Botany, Pennsylvania State College. No. 2.

Ascomycetes in which he demonstrated the pleomorphic condition of this class. His researches were based upon the comparison of many forms, their co-habitation, anatomy, and the alternation of their spore-forms. In this way he was able to work out the alternate asexual stages of a number of Ascomycetes.

It may be mentioned that as a result of Tulasne's work a storm of controversy developed which lasted for some time. On the one hand, pleomorphy was considered ridiculous by the most conservative botanists of the time, while on the other hand his results led men of overenthusiasm to ridiculous conclusions.

Owing to the importance of this group on account of its large number of species and their common association with plant diseases, it has occurred to the writer that any constant similarity existing between the conidial and ascigerous stages which might enable an investigator to conclude with some degree of certainty whether two stages are related would be of great assistance. This information would be all the more valuable provided that it was of such a nature that it might be ascertained by a comparative study of the spores.

While the author[2] was working upon the correlation existing between certain species of rusts his attention was first called to the similarity between conidia and ascospores of certain species of Ascomycetes, the genetic connection of which has been demonstrated. This paper is the result of observations and notes taken from time to time upon such species as may be said to show structural parallelism between their conidia and ascospores.

A similar parallelism between certain spore-forms in the Uredinales has been pointed out by Arthur[3], who worked out the connection existing between *Aecidium verbenicola* and *Puccinia Vilfae,*[3] *Aecidium Traxini* and *Puccinia peridermiospora,*[4] and *Aecidium Cephalanthi* and *Puccinia Seymouriana.*[5] He compared the peculiar morphology of the aeciospores with the same peculi-

[2] Orton, C. R., Correlation between certain species of *Puccinia* and *Uromyces.* Mycologia 4: 194–204. 1912.

[3] Arthur, J. C., Cultures of Uredineae in 1899. Bot. Gaz. 29: 268–276. 1900.

[4] Arthur, J. C., The Uredineae occurring upon *Phragmites, Spartina,* and *Arundinaria* in America. Bot. Gaz. 34: 1–20. 1902.

[5] Arthur, J. C., loc. cit.

arity possessed by the urediniospores of suspected alternate species and proved by cultures that his presumptions were correct.

It has been pointed out by de Bary[6] and others that certain species of Ascomycetes on which both conidial and ascigerous stages are known produce mycelium of "the same qualities and capabilities" from both kinds of spores.

There is frequent allusion to this in mycological literature where physiological studies of the mycelium arising from the conidia of a species have been compared with the mycelium arising from ascospores of the known or suspected alternate stage. In one case which has come to my attention a dissimilarity in this respect was considered of sufficient importance to warrant keeping them separated. This view is certainly a safe one to follow, but no one yet has proved in a sufficiently large number of cases that the mycelia from both spores are identical in a physiological test, such as is made in culture media, to justify final conclusions. Such an identity is possible and, if actual, would prove a valuable test to further substantiate the theory of parallelism as herein indicated.

The following examples will serve to bring out more clearly what the writer has in mind. The powdery mildews show this parallelism in every case with which the writer is familiar. Here, there is in the asexual stage the production of simple, colorless, more or less barrel-shaped conidia corresponding almost in every detail with the ascospores of the connected stge.

In the genera *Rhytisma* and *Lophodermium*, which have the conidial forms *Melasmia* and *Leptostroma* respectively, the same likeness is found. In both, the conidia and ascospores are simple, colorless, and cylindrical. The genus *Glomerella* possesses two conidial stages, *Gloesporium* and *Colletotrichum*, each of which possesses conidia structurally similar to the ascospores of *Glomerella*. Still more striking is the similarity between the ascospores of *Ophionectria coccicola* E. & E. and the conidia of its alternate stage, *Microcera* sp. Both conidia and ascospores are fusoid, colorless, and many-celled. (Fig. 1.)

Herprotrichia nigra has brown, two- to three-septate ascospores

[6] De Bary, A., Morphology and Biology of the Fungi, Mycetozoa and Bacteria (English edition), pp. 225–230. 1887.

which are so like the conidia of the fungus that if a conidium and ascospore were placed side by side they could hardly be told apart.

Such examples might be multiplied many times but only a few more need be enumerated. *Gnomonia, Pseudopeziza, Sclerotinia, Botryosphaeria, Guignardia, Cryptosporella* and others further considered possess this same parallelism.

One might say that the rule does not hold in certain genera of the Sphaeriaceae where the ascospores are two-celled and the conidia of the alternate stage one-celled. This may be explained in all the cases with which the writer is familiar when one observes the germination of the conidia. For example, the conidia of *Endothia parasitica* are unicellular but germinate and produce mycelium from both ends. Eventually, there are four germ-tubes produced, two from each end of the conidium. This is exactly what happens when the ascospore germinates, two germ-tubes being derived from each cell of the ascospore.[7] (Fig. 2.) At the beginning of the germination, the conidium sometimes assumes almost the exact shape of the two-celled ascospore of the fungus. However, the interesting condition remains that, so far as germination is concerned, the pycnospores are parallel with the ascospores.

Another condition exists commonly among the species which possess pleomorphic conidial stages, where, of course, one would expect to find only one of the conidial forms similar to the ascospores. Such a species as *Curcurbitaria Laburni* may be cited here. This species is said to have three types of conidia produced successively in pycnidia of varying form. The first two of these conidial stages produce spores which bear no resemblance to the ascospores, but the third and last conidia produced are almost exactly like the ascospores, which are brown and pluricellular-compound. (Fig. 3.) In this case, as well as in genera like

[7] Anderson, P. J., and Rankin, W. H. Endothia Canker of Chestnut. Cornell Agric. Exp. Sta. Bulletin 347: 566–567. 1914. Since this paper was read, the bulletin cited here has appeared. The action of the nuclei during this process of germination can hardly be as Anderson and Rankin have stated, that "the nuclei pass out into the germ tubes almost as soon as they start." If this were literally true, only two germ-tubes could be derived from one spore, as there would be no nuclei left in the spore to give rise to the two later germ tubes which are developed. Evidently, the writers meant to convey the idea that those nuclei which pass out into the tubes do so immediately.

Pleospora and *Apiosporium*, the likeness between the conidia in one stage and the ascospores is very striking.[8] (Fig. 4.)

A variation of the cases just mentioned, and one which might appear to be an exception, exists in several genera as *Venturia* and *Plowrightia* where the ascospores are two-celled and the conidial stages often unicellular but occasionally two-celled like the ascospores. (Fig. 6.) It might be said here that the mere production of occasional two-celled conidia seems to be of sufficient importance to prove the parallelism, but it is to be noted also that the one-celled spores germinate at both ends and thus function in the same way as does its two-celled companion. This makes the evidence doubly strong that the relationship between conidia and ascospores is very close.

As I have already pointed out, it is manifestly impossible for more than one of the conidial forms of pleomorphic species to be structurally parallel with its ascospores.

Accepting the pleomorphic character of a considerable number of Ascomycetes and allies, why is it not logical to suppose that this condition may be typical of the class and where it fails to appear it may be accounted for by the hypothesis that one or more stages have been lost during the evolution of the group? A majority of the apparent discrepancies in the parallelism of conidia and ascospores may be explained on the supposition that the conidial stages corresponding to the ascospores of the species have been suppressed. This might well be true in such a family as the Hypocreaceae where some of the most apparent incongruities appear. In this family, we find such species as *Nectria galligena*, *N. discophora*, and *Hypomyces Ipomoeae*, in which there is no such manifest similarity. On the other hand, however, in this same family, such species as *Gibberella Saubinetii*, *Ophionectria coccicola*, and *Calonectria graminicola* present striking parallelisms. (Fig. 7.)

[8] Higgins, B. B. Contribution to the Life History and Physiology of *Cylindrosporium* on Stone Fruits. Am. Jour. Bot. 1: 145–173. 1914. Higgins presented at the same meeting at which this paper was read a very interesting case of parallelism in the genus *Coccomyces*, which he has proved to be the ascigerous stage of *Cylindrosporium*. The genus appears to be pleomorphic, at least some species possess three spore stages besides the ascospores. Of the conidial stages, only the *Cylindrosporium* stage appears to function as infection spores and these are almost identical with the ascospores. (Fig. 5.)

There are three possible explanations for these exceptions. *First*, as has just been mentioned, the life history may have become shortened or it may be incompletely known. From the survey of the studies made, this appears to be the most probable condition existing where parallelism fails to appear. *Second*, the supposed conidial and ascigerous stages of a species may have no connection. Numerous instances have been brought to light which show that the original work on the basis of which genetic relationships have been accepted was erroneous. Undoubtedly there are many such assumed connections in this class of fungi. *Third*, the hypothesis falls down completely in certain cases.

While it cannot be said, with our present knowledge of many of the Ascomycetes, that all cases can be made to conform to this theory, yet there seems to be enough evidence presented to show that such a distinct similarity is the rule and that dissimilarity is the exception.

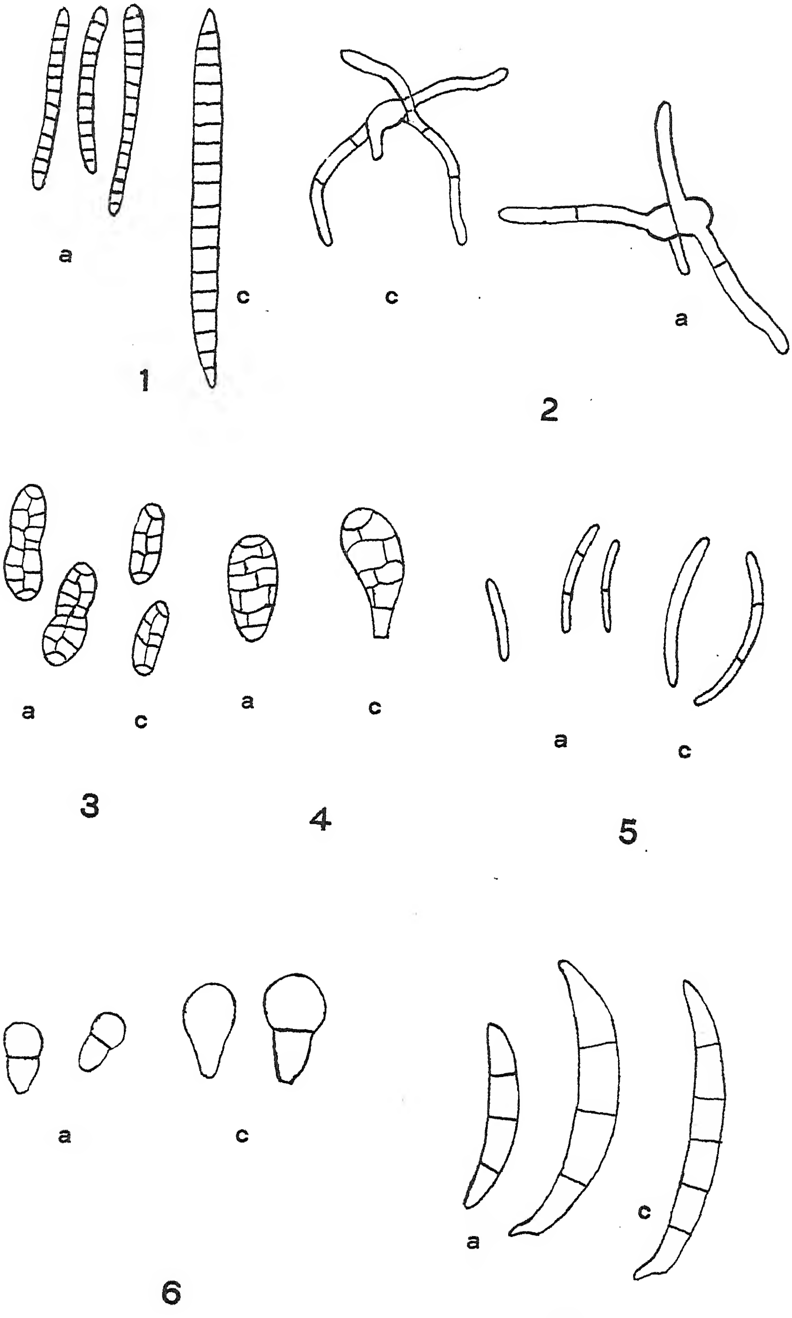
Summarizing these observations, it would seem that among the strictly monomorphic conidial forms of Ascomycetes a rather constant parallelism exists between conidia and the ascospores of the alternate stage; that when one- and two-celled conidia occur, as in *Venturia* and other genera, the ascospores of the alternate stage are generally two-celled; that when the conidia are one-celled and the ascospores two-celled the conidia may in some cases behave as a two-celled spore when they germinate.

Among the pleomorphic conidial species the same likeness probably exists between one of the conidial stages and the ascospores of the alternate stage. Further, it seems probable that when parallelism fails to appear it may be due to abbreviation or to our incomplete knowledge of their life history.

A study of the nuclear phenomenon of the conidial stages during spore formation and germination would undoubtedly throw much light upon the whole subject.

The important feature of parallelism as herein outlined is the assistance given the mycologist and plant pathologist to anticipate with some accuracy the probable relationship between conidial and ascosporic stages.

Thanks are due Professors R. A. Harper and F. D. Kern for



SPORE-FORMS IN THE ASCOMYCETES

helpful criticism during the preparation of the manuscript for publication.

PENNSYLVANIA STATE COLLEGE,
STATE COLLEGE, PA.

EXPLANATION OF PLATE CLII

All figures except figure 2 are magnified about 100 times

Fig. 1. *Ophionectria.* Adapted from Florida Bulletin 119. *A.* Ascospores. *B.* Conidium.

Fig. 2. *Endothia parasitica.* Redrawn from Cornell Bulletin 347. *A.* Ascospore germinating. *C.* Conidium germinating.

Fig. 3. *Curcurbitaria.* *A.* Ascospores. *C.* Conidia.

Fig. 4. *Pleospora.* *A.* Ascospore. *C.* Conidium.

Fig. 5. *Coccomyces.* Redrawn from Higgins. *A.* Ascospores. *C.* Conidia.

Fig. 6. *Venturia.* *A.* Ascospores. *C.* Conidia.

Fig. 7. *Gibberella.* *A.* Ascospore. *C.* Conidia.

THE TAXONOMIC VALUE OF PORE CHARACTERS IN THE GRASS AND SEDGE RUSTS[1]

J. C. Arthur and F. D. Fromme

It is only in recent years that the germ-pores of the urediniospores of the rusts have been the objects of critical study by the mycologist. This study has been prompted by the desire to find additional morphological characters of sufficient constancy and clearness for taxonomic purposes.

The first consistent use of urediniospore-pore characters in the description of rust species was made by the senior author of this paper in the second number of the North American Uredineae, issued in 1898 and printed in the Bulletin of the University of Iowa. They had occasionally been incorporated in descriptions prior to this but had not been used with any constancy. The prevailing tendency had been to regard all of the urediniosporic characters as of slight taxonomic value and to place the greater dependency on characters of the teliospores. The recent authors of systematic works on the rusts who have used urediniospore-pores most consistently are Fischer, Holway, Bubak and Grove. None of these authors, however, have incorporated these pore characters in their keys as has been done in the rust part of the North American Flora, the first number of which was issued in 1907.

In no groups of the rusts has the taxonomist's need of sharply distinctive morphological characters been more imperative than in those which have their uredinial and telial stages on grass and sedge hosts. These are included under two genera, *Nigredo* (*Uromyces* in part) and *Dicaeoma* (*Puccinia* in part); the former with one-celled and the latter with two-celled teliospores. There is a growing belief, which has been strengthened by the study of the urediniospore-pores, that there is no essential difference between the two genera and that the presence of more than one cell

[1] Read before the Botanists of the Central States, at the St. Louis meeting, October 17, 1914.

in the teliospore is a racial feature rather than an acceptable morphological basis of separation. When both one- and two-celled teliospores occur together the generic assignment is arbitrary, it being understood that the two-celled spores are to be given preference, even if comparatively few, or if quite absent in part of the sori or on some hosts. The species may still be maintained in two genera for convenience and in conformity with usage. The determination of the species, however generically disposed, on teliosporic characters alone is often a difficult task and sometimes an impossibility, on account of the great similarity of the forms. It has become necessary, therefore, to utilize such other characters as are available and especially those of the urediniospores.

Urediniospores can usually be found in collections of grass and sedge rusts even though no uredinial sori are present. A scraped mount made from a sorus of teliospores will usually contain a few of the other spores even if the collection be made at a season when uredinial production has apparently ceased. There are, however, three species of grass rusts, *Puccinia leptospora, P. Campulosi* and *P. paradoxica,* in none of which have urediniospores been observed. These are rare species represented by single collections only. Teliospores, on the other hand, are by no means an omnipresent spore form of the grass and sedge rusts, They are seldom present in uredinial sori at the optimum growth period of the host, and in many species they are almost entirely wanting throughout the whole season, as in the common rust of blue-grass, *Puccinia epiphylla,* which produces teliospores in North America in alpine or boreal regions only. The urediniospore is, as a rule, the most abundant spore form and its characters are sufficiently constant and distinctive to make it of great value for taxonomic purposes.

The most useful urediniosporic characters are: the form and size of the spore, the color and thickness of the spore wall, its surface sculpturing, and the number and distribution of the germ-pores. Among these the pore characters are perhaps the most valuable. The pores are usually visible in a water mount but it is often better to use a clarifying or staining agent to bring them out distinctly. A small drop of lactic acid mixed with the water in which the spores are mounted, especially if heated to

the boiling point, is very effective, as is also the application of a solution of chloral hydrate and iodine. The latter is particularly serviceable when the spores are fresh and still retain their colored contents. These methods fail, however, in a few species having urediniospores with colorless or thick gelatinized walls. There are five of these species: three, *Puccinia versicolor*, *P. Boutelouae*, and *P. triarticulata*, in which the pores are evidently scattered but the exact number cannot be made out, and two species, *P. Seymouriana* and *P. Melicae*, in which neither the pore number nor distribution is known.

According to our present knowledge there are 145 species of rusts on grass and sedge hosts in North America having available pore characters; 105 species on grasses and 40 on sedges. The following account of urediniospore-pores is based upon this group of species, which includes those with both one- and two-celled teliospores.

In the grass rusts the urediniospore-pores vary in number with the different species from 2 to 12. In species where the pores are restricted to the equatorial zone the most common number is 3 or 4, and where the pores are scattered, 6 or 8.

In the sedge rusts the range of variation, 1 to 5, is much smaller, five pores being the largest number known. The two-pored condition is most common and the one-pored condition, found in two species only, is rare.

The extent of variation in number of pores in a single species is usually small. A variation of four, as from 8 to 12, is the extreme. Many species have a variation of two, as from 2 to 4, 4 to 6, etc., or of one, as from 2 to 3 or 3 to 4, and in many the pore number is fixed.

The real significance of the pore number from the physiological standpoint is not known and no theory to account for the presence or importance of more than one pore in each spore has been put forth. The pore number and distribution are no doubt associated in some way with the development of the species and possibly bear a physiological relation to the host. Their absolute hereditary constancy has never been proven. An apparent physiological modification in the pore number and distribution is known in *Pucinia*

vexans, a common rust of the prairies on species of *Bouteloua*. In addition to the normal thin-walled urediniospores this species produces a resting or amphisporic form of urediniospores. These amphispores have a thick, dark-colored wall and are easily mistaken for teliospores of *Uromyces*. They show their urediniosporic nature, however, by the production of a germ-tube instead of a promycelium, and by their ability to reinfect the same host. The normal urediniospores of this species have eight scattered pores, while the amphispores have four equatorial pores (Fig. 1, *b* and *c*). An explanation of the difference in number and position of the pores in the active and resting urediniospores should give a valuable insight into the evolution of this stage of the rusts.

It is sometimes more difficult to ascertain the disposition of the the pores than their number. This is especially true in a globoid spore, as it is hard to be certain that it is properly orientated, but an ellipsoid or oblong spore will naturally lie upon the proper surface for convenient examination. Three general types of distribution are recognized: scattered, equatorial, extraequatorial.

The term scattered pores does not imply that the pores are without a definite arrangement. They are practically equidistant from each other over the cell surface in the typical scattered-pore condition (Fig. 1, *a*, *b* and *d*).

If the pores are equatorial, they more or less approximate the equator of the spore and are placed at about equal distances apart (Fig. 1, *e*, *f*, *g*, and *h*).

The extraequatorial group may be conveniently subdivided into pores superequatorial, and pores subequatorial. Like the equatorial-pored condition these are zonal arrangements when more than one pore is present. The zone may be slightly above or below the equator (Fig. 1, *j*), considerably above, near the apex (Fig. 1, *i*), or considerably below, near the hilum (Fig. 1, *k* and *l*). Two pores is the constant number for all of the extra-equatorial-pored species except those with pores near the hilum. One species, a grass form, *Puc. Sporoboli*, has three pores arranged in a zone around the hilum, while two species, both sedge forms on species of *Carex*, each have a single pore near the hilum.

The scattered- and equatorial-pored conditions are present in

about equal numbers in the rusts under consideration. There are at present known 63 species with scattered pores and 67 with equatorial pores. Fifteen species have extraequatorial pores, eleven

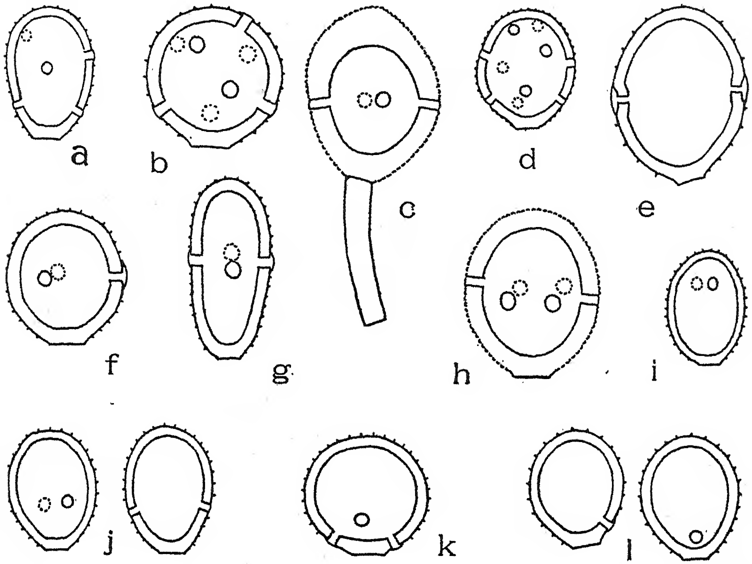


Fig. 1, *a, b, d–l,* urediniospores and *c,* amphispore, all from North American collections: *a, Uromyces Poae,* 5 scattered pores; *b, c, Puccinia vexans,* 8 scattered pores and 4 equatorial pores; *d, P. epiphylla,* 10 scattered pores; *e, P. Cenchri,* 2 equatorial pores; *f, P. Urticae,* 3 equatorial pores; *g, P. poculiformis,* 4 equatorial pores; *h, P. eslavensis,* 6 equatorial pores; *i, P. Caricis-Asteris,* 2 superequatorial pores; *j, P. Caricis-Strictae,* 2 subequatorial pores; *k, P. Sporoboli,* 3 basal pores; *l, Uromyces uniporulus,* 1 basal pore. All spores magnified 625 diameters.

of which are super- and four subequatorial. Expressed in percentage, the different divisions stand as follows: pores equatorial 46.2 per cent.; pores scattered 43.5 per cent.; pores superequatorial 7.6 per cent.; pores subequatorial 2.7 per cent.

None of the grass rusts has superequatorial pores and but a single species has subequatorial pores. All of the remaining species, therefore, in which the pores are known, belong to the scattered- or equatorial-pored groups, 63 species in the former group and 42 in the later.

Among the sedge rusts the scattered-pored condition is very uncommon, being found in but a single species, *i. e., Puc. karelica.*

The equatorial-pored condition is most common here and is present in 25 species, while eleven species have superequatorial pores and three have subequatorial pores.

The practical importance of a thorough understanding of the pore characters of the urediniospores of the grass and sedge rusts, apart from the possible clues of relationship and phylogeny that may be derived from it, lies in the application of the knowledge to the identification of incomplete material. In many cases collections that are of considerable importance in mapping the range of a species or in determining its validity are represented by a few fragments of leaves that the taxonomist is unable to place and the rust material may be scanty and wholly or chiefly in the uredinial stage. The too common practice of gathering a few infected leaves without infloresence or fruit supplemented by the failure to properly label the collection in the field leads to many errors in the naming of hosts which the uredinologist is sometimes able to rectify through the proper identification of the parasite. If a rust in question on an unidentified grass-like fragment of leaf has scattered urediniospore-pores or a greater number than five the assumption is that the host is a grass since but a single sedge rust has scattered pores and none has more than five. If the pores are superequatorial, the host is most certainly a sedge.

With the few broad bases of separation afforded by the pore characters and with the other supplementary characters of the urediniospores, it is often possible to determine the species of rust from urediniosporic material alone, which is a far cry from the situation prevailing not many years ago when grass and sedge rusts, especially the latter, were considered the most difficult of all the rusts to determine, and utterly hopeless when only urediniospores were present.

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A PARASITIC SPECIES OF CLAUDOPUS

Harry Morton Fitzpatrick

(With Plate 153, and 1 Text Figure)

Several of the *Agaricaceae* have been described as parasitic on others of the same group. Of these may be mentioned *Volvaria Loveiana on Clitocybe nebularis*,[1] *Stropharia coprinophila* on *Coprinus atramentarius*,[2] and the species of the genus *Nyctalis*. No instance of a species of the *Agaricaceae* parasitic on one of the *Polyporaceae* appears, however, to have been cited. On August 2, 1914, the writer discovered such a case in Six Mile Gorge, near Ithaca, N. Y. *Polyporus perennis*[3] occurs in this locality in unusual abundance and a few fruit bodies of this fungus were found parasitized a member of the genus *Claudopus*. Study has proved this to be a hitherto undescribed species.

The fruit bodies of the parasite occur in considerable numbers about the mouths of the tubes and along the stipe of the *Polyporus*. They are minute, the expanded pilei in no case exceeding 4 mm. in diameter, while the developmental stages or "buttons" are almost microscopic. The lateral stipe and the salmon-colored gills suggest at once the genus *Claudopus*.

The parasitized host plants, if examined superficially, give little evidence of the presence of the parasite. They exhibit the normal appearance of healthy plants, showing neither hypertrophy nor dwarfing, and viewed from above can in no way be distinguished from the uninfected sporophores. An examination with the hand lens reveals the fact that certain of the tubes of the *Polyporus* in the immediate vicinity of the fruit bodies of the parasite are partially filled with the grayish mycelium of the *Claudopus*. There is no other external evidence of a diseased

[1]Berkeley, J. M. Outlines of British Fungology, *pl. 7, f. 2.* 1860.

[2] Atkinson, G. F. A mushroom parasitic on another mushroom. The Plant World 10: 121–130. *f. 22–24.* 1907.

[3] *Polyporus perennis* Fr. = *Coltricia perennis* (L.) Murrill. North American Flora 9: 92. 1908.

condition, and the sporophores of the *Polyporus* produce their hymenium and spores in the normal manner. Thin sections made through the point of attachment of the stipe of the parasite to the host disclose no marked derangement of the elements of the latter. It is possible to trace to some extent the course of the hyaline hyphae of the *Claudopus* among the deeper-colored threads making up the sporophore of the *Polyporus*. Some of these are found ramifying the trama of the host to a considerable depth. It is possible that they extend through its stipe to the soil. The presence of fruit bodies of the parasite on the stipe furnishes some indication of this.

The mycelium of the parasite is relatively small in amount, and the hyphae of the two fungi lie in close contact and run approximately parallel. Careful search fails to reveal any organs of the nature of haustoria, and dissolution of the host hyphae by enzymes excreted by the parasite appears not to take place. If any such process occurs, the disintegration of the host is insufficient in amount to be evident in thin, free-hand sections.

The method by which natural infection occurs was not determined. Fruit bodies of the *Claudopus* leading a saprophytic existence on neighboring twigs or soil could not be found. It is not impossible, however, that these were produced earlier and had already disappeared. Local infection of the sporophores of the *Polyporus* might result either from spores produced on such saprophytic fruit bodies or from hibernated spores produced the preceding year on parasitic fruit bodies. It seems more probable, however, that the vegetative mycelium of the *Claudopus* spreads in the soil and travels upward among the hyphae of the *Polyporus* during the development of its sporophore. It may thus retain organic connection with the food material in the soil and be partially or wholly independent of the *Polyporus* in its food relationships.

The upper figure in the accompanying plate illustrates well the fruit bodies of the two fungi. A compound structure resulting from the fusion of the pilei of three sporophores of the host plant is shown. The blur at the center of the photograph results from the failure of the stipe of the sporophore to fall into focus. The tendency of the sporophores of *Polyporus perennis* to fuse at the

margins with neighboring fruit bodies is more or less characteristic of the species. It was evident in many of the plants collected, has been described before, and is not to be regarded as due to the presence of the parasite. Nearly one hundred fruit bodies of the *Claudopus*, the majority of them in the "button" stage, may be counted on the single sporophore pictured. They are shown enlarged to approximately two diameters. The lower figure in the plate illustrates the parasite in somewhat more detail, the enlargement here being nearly four diameters.

The fungus must be regarded as a member of the genus *Claudopus*. The stipe is definitely lateral. The spores, salmon-colored in mass, when viewed under the microscope exhibit a distinct pink tint. However, no previously described species of the genus posesses the characters of the fungus on *Polyporus perennis*. No described species of *Pleurotus* or *Crepidotus* resembles it even remotely. The pileus is white, the lamellae are salmon-colored in even the young fruit bodies, and the spores are definitely angular (see text figure 1). Few species of the genus have been described as having angular spores. Only one of these, *Claudopus depluens* Batsch, has a white pileus, and it is described as being sometimes tinged with pink or gray. The minimum measur-

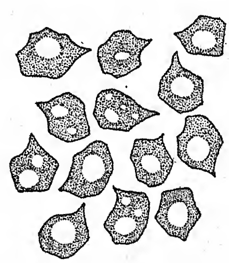
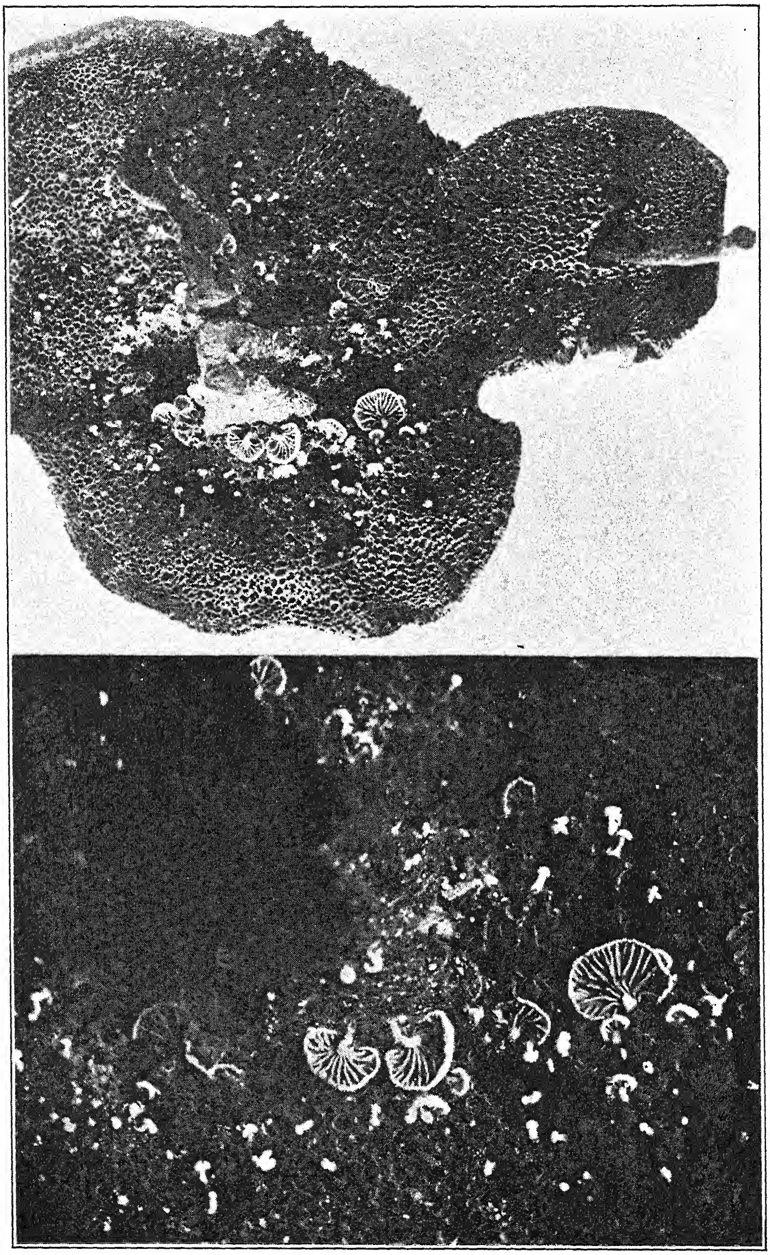


FIG. 1. Spores of *Claudopus subdepluens* Fitzpatrick.

ment (one-half inch) given as the diameter of the pileus of *C. depluens* is three times greater than the maximum of the species under consideration, while average pilei of *C. depluens* are much larger. The fruit bodies of *C. depluens* occur on the ground or on decaying wood, and arise from saprophytic mycelium. The lamellae are at first white, later becoming salmon-colored. The species has been collected in New York and was described by



CLAUDOPUS SUBDEPLUENS FITZPATRICK

Peck.[4] The spores of the two species are approximately the same size, and are both typically uniguttulate. The fungus on *Polyporus perennis* is evidently closely related to *C. depluens*. It cannot, however, if the differences enumerated are taken into consideration, be regarded as identical with it, and the following name is proposed:

Claudopus subdepluens sp. nov.

Pileo e convexo expanso, minuto, 1–4 mm. maximam diam., albo, minute tomentoso, margine sulcato; lamellis ex primo salmoniis, distantibus, adnatis, acie integerrima; stipite albo, laterali, flexuoso, adusque 2 mm. longitudinem, crassitudine minore quam 0.5 mm.; basidiis 4 sterigmatibus praeditis, clavatis; sporis angulosis, 1-guttulatis (raro 2-plus-guttulatis), parum atqui definite roseis, $7–12 \times 6–8$ μ.

Hab. parasiticus in Polyporo perenne, Six Mile Gorge, Ithaca, N. Y. Amer. bor.

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[4] Peck, Chas. New York species of *Pleurotus, Claudopus,* and *Crepidotus.* Ann. Rep. N. Y. State Mus. 39: 68. 1887.

NEW SPECIES OF COLLETOTRICHUM AND PHOMA

P. J. O'Gara

A New Species of Colletotrichum on Clover

During the course of my investigations in the Salt Lake Valley, I have found many clover fields in which the stems and petioles of red clover (*Trifolium pratense* L.) and alsike clover (*Trifolium hybridum* L.) were infected with a *Colletotrichum* which does not agree in its characteristics with *Colletotrichum Trifolii* Bain. However, in many respects the characters of the disease are similar to those of *Colletotrichum Trifolii* as described by Bain and Essary.[1]

The clover plants seem to be most frequently attacked at or near the ground, although it has been noted that the attack may also occur just beneath a cluster of blossoms. As a rule, one's attention is called to the sudden dying of a cluster of blossoms. The petioles and stipules are also attacked.

Specimens of diseased plants were sent to Mrs. F. W. Patterson, mycologist of the U. S. Department of Agriculture, at Washington, D. C., and also to Professor S. M. Bain of the University of Tennessee. Reports from both sources indicate that the disease of red clover and alsike clover as found in the Salt Lake Valley is not caused by *Colletotrichum Trifolii* but by a heretofore undescribed species. A more complete statement of the characteristics of the disease will be made at a later date. The description follows:

Colletotrichum destructivum sp. nov.

Maculis indeterminatis brunneis; *acervulis* minutis 25–70 μ diam., sparsis v. gregariis, erumpentibus, elevatis; *mycelio* hyalino, granuloso; *basidiis* fasciculatis, hyalinis, cylindraceis v. fusoideis, conidiis prope aequalibus; *conidiis* hyalinis, granulosis, 1–4 guttulatis, rectis v. leniter curvulis, utrinque rotundatis 3.5–

[1] S. M. Bain and S. H. Essary. A new anthracnose of alfalfa and red clover. Jour. Myc. 12: 192. 1906.

5 × 14–22 μ; *setulis* inter condidia orientibus, paucis v. numerosis, fuligeneis v. atro-brunneis, subrectis v. curvulis v. flexuosis, saepe nodulosis, continuis v. obscure 1–septatis, subacutis v. rotundatis, sursum angustioribus, basi 4.5–7 μ crassis, 38–205 μ longis.

Hab. in foliis, petiolis caulibusque vivis et languidis Trifolii pratensis, Utah, Amer. bor.

A NEW SPECIES OF COLLETOTRICHUM ON POTATO

A new species of *Colletotrichum* which confines its attacks mostly to the underground stems of the potato has been found in many potato fields in the Salt Lake Valley, Utah. Rarely is this new species found on the stems above the surface of the ground. Sometimes definite, dark-brown or black cankers are produced resembling to some extent those caused by *Rhizoctonia,* but more often the entire underground stem is involved. The mycelium invades the cortex beneath the epidermis and is at first hyaline and few-septate. Later, the mycelium becomes brown and many-celled, and forms sclerotia-like bodies just beneath the epidermis from which arise the setae and conidiophores. When the stems die, the epidermis readily comes off, exposing the dark-brown or black sclerotia-like bodies. The fungus has been cultivated in the laboratory for some time, and reproduces characteristically. It is related to *Vermicularia.*

Colletotrichum solanicolum sp. nov.

Maculis plus minusve indeterminatis atro-brunneis vel nigris, plerumque in caulibus subterraneis, saepe totum partem caulii subteranii occupantibus; *acervulis* numerosis, irregulariter sparsis vel subgregariis, primo epidermide tectis, demum erumpentibus; *mycelio* in cellulis corticis primo hyalino et parce septato, deinde brunneo, pluriseptato, sclerotioideo, conidia setasque gerente; *setis* fasciculatis, numerosis, atro-brunneis, ad apicem saepe pallidioribus, rectis, vel leniter curvulatis vel flexuosis, apice obtusis vel acutis, 1–3 septatis, 90–260 μ longis, cellula inferiore leniter inflatis, 6–7 μ crassis; *conidiophoris* inter setulis orientibus, subhyalinis, granulosis, brevibus, 2–8 μ longis; *conidiis* continuiis, 3.5–5 × 17–22 μ, rectis vel leniter curvulatis, apice rotundatis, ad basim leniter attenuatis, hyalinis, granulosis, saepe 1–3 guttulatis. maturescentibus vacuolum leniter refringens medio continentibus.

Hab. in caulibus subterraneis vivis et emortuis *Solani tuberosi,* Salt Lake Valley, Utah, Amer. bor.

A New Species of Colletotrichum on Asclepias

My attention was called to an interesting anthracnose of *Asclepias speciosa* by Mr. W. W. Jones, botanist in the laboratory of plant pathology, department of agricultural investigations, American Smelting and Refining Company. Upon careful study of the disease, it was found that a new species of *Colletotrichum*, more or less intermediate between *Gloeosporium* and *Colletotrichum*, proved to be the causative agent. It is interesting to note that this new species of *Colletotrichum* produces very few setae; very often they are entirely wanting. The fungus attacks both the foliage and the stems, producing characteristic irregular spots on the foliage and most often a complete girdling of the stems near the base. The spots on the stems when not confluent are more or less elliptical. The conidial masses on both foliage and stems are distinctly salmon-colored in fresh specimens. Diseased plants are easily noted by the premature yellowing of the foliage.

A more complete description will be presented later when the cultural work has been completed. The description of the species is as follows:

Colletotrichum salmonicolor sp. nov.

Maculis in caulibus et foliis, brunneis, atro-brunneo-marginatis. *Maculis* in foliis amphigenis, irregularibus, leniter depressis, 2–6 mil. diam., saepe confluentibus. *Maculis* in caulibus, lenticulatis, saepe confluentibus, initio leniter depressis, deinde elevatis, 2–7 mil. long. *Acervulis* amphigenis, sed in hypophyllo copiosoribus, minutis, numerosis, irregularibus, elevatis, dense aggregatis interdum confluentibus, initio epidermide velatis, dein erumpentibus, massa conidiorum salmonicoloratis erumpente; *conidiis* subhyalinis, granulosis, 2–4 guttulatis, irregularibus, rectis vel levissime curvatis, saepe ad basim leviter attenuatis et summo rotundatis, $5–6 \times 17.5–35\ \mu$; *basidiis* hyalinis, granulosis, conidio subaequilongis; *mycelio* parce vel non septato; *setulis* erectis, sparsis, paucis, saepe nullis, superne acutis $1.5\ \mu$ crassis, inferne $9\ \mu$ crassis, 2–3 septatis et $75–105\ \mu$ longis, rectis vel leniter curvulatis, saepe nodulosis, atro-fuligineis vel brunneis, cellula inferiori subhyalina.

Hab. in caulibus et foliis vivis et languescentibus *Asclepiadis speciosae*, Salt Lake Valley, Utah, Amer. bor.

A NEW SPECIES OF PHOMA ON ASCLEPIAS

Upon examining some mycological collections made by W. W. Jones of this department during the past season in the Salt Lake Valley, Utah, I found an interesting *Phoma* on the stems and foliage of *Asclepias speciosa* Torr. The examination of many specimens showed that in every instance it was associated with *Cercospora clavata* (Ger.) Peck. The leaf and stem spots always showed the presence of both the *Phoma* and *Cercospora*. In some cases definite areas of the spots were covered by both species, but often the pycnidia of the *Phoma* and the acervuli of the *Cercospora* are intermingled. Where definite areas of the spots are covered by the two species, it is easy to recognize one from the other by noting the lighter-colored brown areas of the *Cercospora* as contrasted with the dark-brown or black-colored areas occupied by the *Phoma*. Carefully prepared microtome sections show the intermingling of the mycelium of both species. In the *Phoma* leaf-spots, practically the entire structure between the upper and lower epidermis is destroyed, and the space occupied by the light-brown mycelium. Pycnidia are often distinctly beaked. The description of this species is as follows:

Phoma rostrata sp. nov.

Maculis in caulibus lenticulatis vel elongatis; in foliis amphigenis irregularibus, nervulis limitatis, atro-brunneis vel nigris; *peritheciis* sparsis vel dense gregariis, brunneis vel atro-brunneis, semi-immersis, globosis, prominulis vel rostratis, 56–95 μ diam.; *mycelio* in cellulis hospitis brunneo, ramoso, pluriseptato, hyphis circa 3 μ diam.; *sporulis* $1.4–2.3 \times 4–6\ \mu$, eguttulatis, oblongis, utrinque rotundatis, plerumque leniter curvulatis; basidiis non vivis.

Hab. in foliis et caulibus vivis et languidis *Asclepiadis speciosae*, cum *Cercospora clavata* in eisdem maculis sociata, Salt Lake Valley, Utah, Amer. bor.

LABORATORY OF PLANT PATHOLOGY,
DEPARTMENT OF AGRICULTURAL INVESTIGATIONS,
AMERICAN SMELTING & REFINING COMPANY,
SALT LAKE CITY, UTAH.

LIND'S WORK ON THE ROSTRUP HERBARIUM

LARS ROMELL

I beg to draw the attention of mycologists to an excellent work on Danish fungi as represented in the herbarium of E. Rostrup, revised by J. Lind. It is a big volume of about 650 pages in large 8vo, printed at the expense of the Carlsberg Fund.

The author, whose thoroughness and eminent ability we know from his previous publications, has in this monumental work proved himself a mycologist of high rank.

A general idea of the aim and outline of the work may be obtained from the following statement from Lind's introduction: Shortly after the death of Professor E. Rostrup, Ph.D., which occurred on January 16, 1907, I was intrusted with the honorable task of preparing a list of all the species of Danish fungi found in his herbarium. This herbarium was acquired by the University of Copenhagen and has been included in the Botanical Museum of the University. On account of the copiousness of this herbarium, the list will comprise all species of fungi which have hitherto been found in Denmark belonging to the groups of fungi with which Rostrup was mostly occupied. However, in preparing the list, I have also endeavored to point out what an uncommonly diligent man and accurate investigator Rostrup has been. It was my intention in this way to establish a memorial in honor of E. Rostrup as a mycologist and phytopathologist which shall bear witness in foreign countries to the modest and laborious man whose importance as a scientist was never fully understood because he mostly wrote in Danish.

The subject matter of the first part of the book (pages 1–47) may be suggested from the following heads: "The collection of Danish fungi left by the late Professor E. Rostrup," "Danish mycologists previous to Rostrup," "Phytopathology in Denmark before Rostrup," "The assistants of E. Rostrup in the mycological investigation of Denmark," "Foreigners who have taken

part in the mycological investigation of Denmark," "The plan of the work."

This part gives a most valuable exposition of the history of the mycological exploration of Denmark from the middle of the seventeenth century up to the present time. The list of contributors to this exploration is quite large, and biological notes of interest accompany each name, while the most important ones are treated in detail and the following are illustrated by portraits, viz.: E. Rostrup, Th. Holmskjold, G. C. E. von Oeder, O. F. Müller, M. Vahl, C. F. Schumacher, A. S. Oersted, J. C. Fabricius, E. C. Hansen, J. L. Jensen, M. L. Mortensen, P. Nielsen, and C. J. Johanson.

The second or main part of the work (pages 49–550) gives a systematic exposition of all known Danish species (3,324 in number) of Phycomycetes, Ascomycetes, Basidiomycetes, and Fungi Imperfecti. This is, however, no mere list of names. It is a critical and thorough revision of these great groups of fungi with diagnoses or interesting comments accompanying a large number of the species and with many excellent illustrations. Some of the species are here published for the first time.

As to nomenclature, the author says: "I have followed the rules for nomenclature adopted at the International Congress in Brussels, in May, 1910, viz.: that Fries' 'Systema Mycologicum' should be the starting point for the nomenclature of the fungi, except for the Uredinales, Ustilaginales, and Gasteromycetes, which date from Persoon's 'Synopsis.'"

The third part (pages from 555 to the end) contains a "List of literature," "Index of Danish names," and "Index universalis."

The work is written in English and can be used with advantage all over the world. I cannot abstain from strongly recommending it to every mycologist. The price is 20 danish crowns (about 5½ dollars).

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SWEDEN.

A NEW BOLETE FROM CALIFORNIA

William A. Murrill

In a collection of boletes recently received from the department of botany of the University of California, the following is not only new but also of special interest because of its rather unusual characters:

Rostkovites californicus sp. nov.

Pileus thick, convex to plane, solitary, 6–9 cm. broad; surface smooth, conspicuously subtomentose, brown, margin concolorous, entire, rather thick; context thick, fleshy, flavous, unchanging, taste mild; tubes adnate, plane or slightly convex in mass, 4–6 mm. long, yellow, exuding drops which blacken with age, mouths large, angular; spores oblong-ellipsoid, smooth, yellowish-brown, $7\text{–}8 \times 3.5\text{–}4\ \mu$; stipe subequal or bulbous, smooth, yellow, with black dots, unchanging, solid, yellow within, unchanging, 3–6 cm. long, 1.5–2 cm. thick.

Type collected on the ground in pine woods in Grass Valley, California, November 12, 1914, *H. S. Yates & F. H. Bolster 251* (herb. N. Y. Bot. Gard.). Excellent field notes accompany the specimens. The species is strikingly different from other members of the genus in having a conspicuously subtomentose surface resembling that of *Ceriomyces communis*.

NOTES, NEWS AND REVIEWS

Professor Bruce Fink held a research scholarship at the Garden in December, 1914, and delivered a special address on lichen taxonomy before the Torrey Botanical Club.

Professor L. H. Pennington completed his studies of the temperate species of Marasmius at the Garden during the latter part of December.

Professor W. C. Coker has sent in a valuable collection of gill-fungi from Chapel Hill, North Carolina, containing a splendid representation of several difficult species.

Dr. Frederick D. Heald has been appointed professor of plant pathology and pathologist at the State College and Experiment Station, Pullman, Washington.

The American Journal of Botany for July, 1914, contains an article on the origin and development of the lamellae in *Coprinus micaceus*, by Dr. Michael Levine, which forms a valuable addition to the scanty literature of the morphology of the higher fungi.

In the Report of the Connecticut Agricultural Experiment Station for 1913, Dr. G. P. Clinton discusses rather fully the so-called chestnut blight poisoning and decides that the chestnuts eaten by the persons affected could have had no distinctive poisonous properties, but may have been imperfectly matured owing to the trees being attacked by the blight.

The life history and physiology of *Cylindrosporium* on stone fruits is ably treated in an article by B. B. Higgins in the *American Journal of Botany* for April, 1914. Dr. Higgins describes two species as new, *Coccomyces prunophorae* and *C. lutescens*, in addition to *C. hiemalis* previously described by him in *Science*.

Mr. F. J. Veihmeyer, in Bulletin 127 of the U. S. Department of Agriculture, discusses the Mycogone disease of mushrooms and its control. This disease has been known in Europe for at least three generations and has been very destructive to mushroom beds. It was reported in America only a few years ago and now threatens the mushroom industry in certain localities. Methods of prevention and control are discussed at length in this bulletin.

Plants of *Oenothera Tracyi* grown at the New York Botanical Garden during the past two years have had their leaves almost completely covered with mildew (*Erysiphe*), which gives them a decided grayish-white color. Plants of *O. grandiflora*, however, growing by the side of *O. Tracyi* seem to be completely immune from the attacks of this fungus and their foliage has remained bright-green throughout.

The *Strumella* disease of oak and chestnut trees is described and fully illustrated by F. D. Heald and R. A. Studhalter in Bulletin 10 of the Pennsylvania Department of Forestry. This disease very much resembles the chestnut canker and attacks not only chestnut but also various species of oak in the northeastern United States. The fungus, *Strumella coryneoidea* Sacc. & Wint., is an old species, but has not previously been considered parasitic in habit. The investigations in this bulletin have been confined to the state of Pennsylvania.

A very interesting list of wood-destroying fungi which grow on both deciduous and coniferous trees, by James R. Weir, appears in the August number of *Phytopathology*. These observations show that too much dependence must not be placed on the host as an aid in determining certain wood-loving species. One of the most striking instances recorded by the author is that of *Grifola Berkeleyi* attacking the roots of the larch in the Kaniksu National Forest of Idaho. This handsome species is known in the East only on oak.

The Transactions of the Wisconsin Academy of Sciences, Arts, and Letters, Volume 17, Part 2, issued in October, 1914, contains several very important mycological contributions. Bernard O. Dodge contributes a list of fungi, chiefly saprophytes, from the region of Kewaunee County, Wisconsin, including 400 species from Kewaunee County and 40 additional species from Juneau and Dane Counties listed because of their special interest. About 90 species of discomycetes found in this same region were also listed by Dr. Dodge in another paper in the same publication. Both of Dr. Dodge's papers contain locality and descriptive notes of much interest and value. No new species are included. A provisional list of parasitic fungi found in Wisconsin, with a host index, is contributed by J. J. Davis. The list is a long one and does not admit of notes. Edward T. Harper makes another very important contribution to his studies of the larger gill-fungi occurring in the region of the Great Lakes by describing and illustrating very fully and accurately 13 species of *Hypholoma,* including some of the most difficult forms in the family.

Another important contribution to the literature of the chestnut canker recently appeared as Bulletin 347 of the Cornell University Agricultural Experiment Station by P. J. Anderson and W. H. Rankin. This is a very complete treatment of the subject and contains an account of many original investigations and experiments extending over a period of years. Regarding the outlook for the chestnut tree in America the authors make the following statement: "At present we know of nothing that will prevent the extermination of the American chestnut tree. Every measure of control that has been tried has been abandoned north of West Virginia and the Potomac River. Some persons have expressed the belief that nature herself will intervene to prevent destruction of the species; the virulence of the pathogen will abate, the resistance of the host will be increased, or natural enemies—insects or fungous parasites—will destroy, or at least check, the pathogen. Up to the present, however, there has been no indication of relief along any of these lines. But we do not believe that the ingenuity of our scientists has been exhausted; that further research will bring to light some methods of combating the disease is not beyond the limit of probability."

PHILADELPHIA MEETING OF THE PHYTOPATHOLOGICAL SOCIETY

The American Phytopathological Society held its sixth annual meeting in Philadelphia, December 29-January 1. Abstracts of the large number of interesting papers presented at this meeting have already appeared in *Phytopathology*, the official organ of the society. At the business meeting on January 1, the following officers were elected for the ensuing year: President, H. H. Whetzel; Vice-President, W. A. Orton; Secretary-Treasurer, C. L. Shear, Councilor, M. T. Cook.

The retiring president, Dr. Haven Metcalf, ran all the programs on schedule time, which permitted important discussions. He also showed wisdom in grouping papers on the same general subject. This method applied particularly well to the number of "spot diseases" on apple and other fruits, discussed by Waite, Brooks, Fisher, Reed, Martin, and others.

A plant disease survey is being organized by Mr. R. Kent Beattie, of the Bureau of Plant Industry at Washington, its object being to collect and classify all available data on the distribution of plant diseases in the United States. Plant pathologists are urged to send in specimens, which will be checked as to determination and placed in the herbarium for consultation.

Phytopathology, the official organ of the society, was discussed at length by Dr. Jones and others, who emphasized the fact that the time has come when articles of small scientific value cannot be accepted for publication and money must be obtained for good illustrations, either by contributions from the members or from an endowment. It was held to be the duty of American mycologists to see that American papers of merit are illustrated in the very best possible manner.

Special attention may be called at this time to the following papers:

Professor J. C. Arthur reported *Uredo nootkatensis* from Alaska and other parts of the Pacific Coast as a *Gymnosporangium* with repeating spores. The aecial stage of this species is *Aecidium Sorbi*.

Mr. George L. Peltier reported results of extensive experiments with *Rhizoctonia* in America, over 57 strains having been personally investigated. The common species is *Rhizoctonia Solani*.

Mr. E. W. Sinnott outlined a method for the microscopic study of decaying wood, which consisted in softening, imbedding in celloidin, and staining with methyl violet or other differential stain.

Mr. A. G. Johnson discussed the ascigerous stage of *Helminthosporium teres* Sacc. on barley, which was found to be a *Pleospora*. This perfect stage has been reported for *H. gramineum*, but there is no doubt that it is connected with *H. teres* instead.

A very interesting report was made by Dr. L. R. Jones on lightning injury to cotton and potato plants. This accounts for areas that have been observed where the plants died suddenly from no observable cause. One case was mentioned of lightning injury to corn in Kansas.

Mr. W. A. Orton spoke very briefly of the results of the potato study trip of 1914 and stated that no report of the trip as such would be published, but that the important observations and results would be put into available form at an early date. He is planning to have a meeting of those interested in the subject in Maine next August.

Mr. Harry M. Fitzpatrick reported results of his studies on *Eocronartium typhuloides*, a species intermediate between the Auriculariaceae and the higher basidiomycetes. He found it to be a true parasite on mosses. After examining authentic specimens from Europe, he has decided that *E. typhuloides* Atk., *Clavaria muscigena* P. Karst., and *Typhula muscicola* Fries are identical, the last mentioned name being the oldest.

A report by Dr. L. R. Jones on further experiments with fusarium-resistant cabbage proved very interesting. In 1910, the "yellows" was so bad in Wisconsin that most of the cabbages were killed. However, a few survived, which were selected as resistant strains. The process of selection has been continued since that time and Dr. Jones is now ready to distribute seed from these selected strains, which will yield remarkable results, the best yielding 95.5 per cent. of heads and 19 tons per acre, while the commercial strain from which the resistant strain was derived yielded only 17 per cent. of heads and a little over 2 tons per acre. It looks as though the disease produced by *Fusarium conglutinans* might be entirely eliminated by this process of selection.

Mr. W. M. Scott described and discussed a new fungicide which may replace lime-sulfur for spraying fruit trees. It is prepared by using barium instead of calcium in combination with sulfur, which permits the shipment of the fungicide in the dry state. This is much more convenient, while the price should be about the same and the results fully as beneficial. Lime-sulfur mixture is generally used now instead of Bordeaux for orchard work. The yellowish color is not objectionable to fruit trees but makes it impossible for parks. The new substance costs at present 4 cents a pound. The dry crystalline substance consists of 85 per cent. of barium tetrasulfid and a small percentage of barium thiosulfate and free sulfur. When this crystalline substance is dissolved in cold water, preparatory to spraying, some of the free sulfur unites with the tetrasulfid, forming pentasulfid. It has has been determined that it is the polysulfid of barium rather than the thiosulfate or free sulfur that is beneficial.

The last paper on the program was by Miss Caroline Rumbold, showing some effects on chestnut trees of the injection of chemicals. Tree injection is difficult because there is no blood in the tree to distribute the chemical, which is apt to go up and down in a restricted area. Openings were made on different sides of the tree trunks and fluids of various compositions and strength were injected through tubes clamped to the trunk. Analine stains were first used to determine the best methods of injection. No practical results with the chestnut canker were obtained, but it is hoped that some methods will be devised whereby valuable trees may be saved when attacked by diseases beneath the bark.

W. A. MURRILL.

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Thaxter, R. On certain peculiar fungus-parasites of living insects. Bot. Gaz. **58**: 235–253. *pl. 16–19*. 15 S 1914.

Includes *Muiogone, Muiaria, Chantransiopsis, Amphoromorpha,* gen. nov. and *Hormiscium myrmecophilum, Muiogone Chromopteri, Muiaria gracilis, M. Lonchaeana, M. armata, M. repens, Chantransiopsis decumbens, C. stipata, C. Xantholini,* and *Amphoromorpha entomophila,* spp. nov.

Thaxer, R. New or peculiar Zygomycetes **3**: *Blakeslea, Dissophora* and *Haplosporangium,* nova genera. Bot. Gaz. **58**: 353–366. *pl. 26–29*. 15 O 1914.

Includes *Blakeslea trispora, Dissophora decumbens, Haplosporangium bisporale,* and *H. decipiens,* spp. nov.

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MYCOLOGIA

VOL. VII MARCH, 1915 No. 2

WILLIAM WIRT CALKINS, AMATEUR MYCOLOGIST

BRUCE FINK

(WITH PLATE 154)

Mr. William Wirt Calkins was born May 29, 1842, and died July 9, 1914. Illinois was his native state and remained his residence throughout his life. He prepared for Yale, and began teaching as a ward principal in Ottawa, Illinois, in 1862. However, he soon resigned, enlisted, and served in the Civil War until its close. At the close of the war, he entered business life and studied law. His life was devoted mainly to law and to literary work.

Mr. Calkins was a lover of the natural sciences from boyhood. His earliest interest was in the study of rocks and fossils, but, unfortunately, his large collection was destroyed in the Chicago fire of 1871. After this, he studied conchology, and a number of papers on this subject appeared. About the same time, he began the study of seed-plants, and his collection of about 4000 species is now in the herbarium of the University of Notre Dame. He began the study of fungi about 1885, and papers on lichens and other fungi began to appear at once. Though he collected and distributed large numbers of fungi of various kinds collected in the South and mainly in Florida, it is apparent both from his publications and from conversations and correspondence with him that he soon gave up all other fungi for the lichens, which remained his main botanical interest until the time of his death.

[MYCOLOGIA for January, 1915 (7: 1–55), was issued February 3, 1915.]

His collection of mosses and lichens still remains in the possession of Mrs. Calkins. This collection contains 25 or 30 new species of lichens collected by Mr. Calkins and named mostly by William Nylander. Many of his other fungi were distributed by Ellis and Everhart.

Mr. Calkins was an amateur scientist, who was possessed of a genuine love of nature. Conditions of life prevented his entering the ranks of professional naturalists, but he never lost his relish for the study of natural science. He will be remembered by botanists as a keen-eyed collector of plants, who has by his field work materially added to our knowledge of various kinds of fungi. Some of his specimens will always remain in various American herbaria.

It will be of interest to botanists to know that Mr. Calkins was a prolific writer from early manhood. His first papers, in 1860, were on geology, and the whole number of papers and books to the time of his death was about 150. These writings covered titles on geology, conchology and other zoological subjects, war correspondence, various historical papers, and other miscellaneous topics. His history of the 104th Illinois regiment is a work of 518 pages, and there are one or two smaller historical books. His largest scientific paper seems to have been "The Lichen Flora of Cook County, Illinois"—a work of 50 pages with brief diagnoses of 125 lichens. There is added below a nearly complete bibliography of his botanical papers. Two papers on "The Flora about Berwyn, Illinois" published in "The Berwyn Current," in 1907, eight or nine botanical papers in "the Ottawa (Ill.) Republican," from 1880 to 1892, and three papers in the first volume of "The Valley Naturalist," some of which contain botanical material, have not been seen and therefore are not listed. The available titles are as follows:

1. **Calkins, W. W.** Rambles of a Naturalist in Southern Florida. Cinn. Quart. Journ. Sci. 2: 161–164. 1875. Mainly on the fauna with a few notes on seed-plants and marine algae. Another paper under a different title was published in the same volume, but is devoted wholly to the fauna.

2. **Calkins, W. W.** Notes on the winter Flora of Florida. Bot. Gaz. 2: 128–129. 1877.

3. **Calkins, W. W.** Tillandsias under cultivation. Bot. Gaz. 4: 209–210. 1879.

4. **Calkins, W. W.** January flora of the Indian River country, Florida. Bot. Gaz. 4: 242. 1879.

5. **Calkins, W. W.** Winter herborizations on Indian River, Florida. Bot. Gaz. 5: 57–58. 1880.

6. **Calkins, W. W.** Botanical observations in Florida. Valley Natualist 2: 20–21 and 35–36. 1880. Notes on a considerable number of seed-plants.

7. **Calkins, W. W.** *Epidendrum cochleatum* L. Bot. Gaz. 7: 144. 1882.

8. **Calkins, W. W.** The W. W. Calkins collection of Florida woods. 1–10. Chicago, 1883.

9. **Calkins, W. W.** Notes on some little known Florida trees. Am. Journ. Forestry 1: 386–389. 1883.

10. **Calkins, W. W.** Notes on Florida lichens. Bot. Gaz. 10: 369–370. 1885. A note stating that he found 80 species.

11. **Calkins, W. W.** Catalogue of lichens collected in Florida in 1885, with notes. Journ. Mycol. 2: 112–114. 1886. A list of 73 species determined by Henry Willey.

12. **Calkins, W. W.** *Polyporus officinalis.* Journ. Mycol. 2: 107. 1886.

13. **Calkins, W. W.** Notes on Florida fungi.—No. 1. Journ. Mycol. 2: 6–7. 1886.

14. **Calkins, W. W.** Notes on Florida fungi.—No. 2. Journ. Mycol. 2: 23. 1886. This paper and number one of the series deals with higher basidiomycetes mainly.

15. **Calkins, W. W.** The leaf fungi of Florida.—No. 3. Journ. Mycol. 2: 42. 1886.

16. **Calkins, W. W.** Cryptogamic botany of a Florida log.—Paper 4. Journ. Mycol. 2: 53–54. 1886. Notes on 15 lichens and other fungi found on a giant log in a hummock.

17. **Calkins, W. W.** Notes on Florida fungi.—No. 5. Journ. Mycol. 2: 70. 1886. Notes on a few higher basidiomycetes.

18. **Calkins, W. W.** Notes on Florida fungi.—No. 6. Journ. Mycol. 2: 80–81. 1886. Remarks on the small number of basidiomycetes found in pine woods.

19. **Calkins, W. W.** Notes on Florida fungi.—No. 7. Journ. Mycol. 2: 89–91. 1886. A list of 35 polypores collected near Jacksonville and named by J. B. Ellis.

20. **Calkins, W. W.** Notes on Florida fungi.—No. 8. Journ. Mycol. 2: 104–106. 1886. A continuation of the last, giving numbers 36 to 78 of the higher basidiomycetes collected near Jacksonville and determined by Mr. Ellis.

21. **Calkins, W. W.** Notes on Florida fungi.—No. 9. Journ. Mycol. 2: 126–128. 1886. A continuation of the Florida fungi, listing numbers 79 to 136,—basidiomycetes and ascomycetes.

22. **Calkins, W. W.** Notes on Florida fungi.—No. 10. Journ. Mycol. 3: 7. 1887. A list of various fungi, continuing the list to number 163.

23. **Calkins, W. W.** Notes on Florida fungi.—No. 11. Journ. Mycol. 3: 33–34. 1887. A continuation of the list of fungi to number 183. This paper includes only polypores.

24. **Calkins, W. W.** Notes on Florida fungi.—No. 12. Journ. Mycol. 3: 46. 1887. Numbers 184 to 216, mostly higher basidiomycetes with a few ascomycetes.

25. **Calkins, W. W.** Notes on Florida fungi.—No. 13. Journ. Mycol. 3: 58–59. 1887. Numbers 217 to 250, various fungi.

26. **Calkins, W. W.** Notes on Florida fungi.—No. 14. Journ. Mycol. 3: 70. 1887. Numbers 251 to 280, various fungi.

27. **Calkins, W. W.** Notes on Florda fungi.—No. 15. Journ. Mycol. 3: 82. 1887. Numbers 281 to 300, various fungi.

28. **Calkins, W. W.** Notes on new Florida lichens. Bull. Torr. Bot. Club 16: 330. 1889. A list of six species named by Dr. W. Nylander.

29. **Calkins, W. W.** Notes on rare East Tennessee lichens. Am. Nat. 24: 1078–1079. 1890. Thirty-three species listed with notes.

30. **Calkins, W. W.** An edible lichen not heretofore noted as such. Bot. Gaz. 17: 418. 1892. Discusses *Endocarpon miniatum* (L.).

31. **Calkins, W. W.** Remarks on North American lichenology,—preliminary. Science 20: 120. 1892.

32. **Calkins, W. W.** Remarks on American lichenology.—II. Science 20: 205–206. 1892.

33. **Calkins, W. W.** Remarks on American lichenology.—III. Science 21: 77–78. 1893. Notes on some 20 lichens collected near Jacksonville, Florida.

34. **Calkins, W. W.** The lichen flora of Chicago and vicinity. Chicago Acad. Sci. 1: 1–50. 1896. Contains short diagnoses of 125 lichens. *Verrucaria prospersella* is described as new.

35. **Calkins, W. W.** Mosses of Cook County, Illinois. Bryologist 13: 107–111. 1910. A list of 51 species with notes on habitat and locality.

36. **Eckfeldt, J. W. and Calkins, W. W.** The lichen flora of Florida. Journ. Mycol. 3: 121–126 and 133–137. 1887. A list of 330 lichens with notes. Nine species were listed as new, *nomina nuda*. These have been described since.

37. **Huett, J. W.** Natural history of La Salle County, Illinois. Part 2. Geology and Zoology. 1–174. *pl. 1–3.* Ottawa, Illinois, Fair Dealer Print, 1898. Pages 120 to 149 contain "The Lichen-flora of La Salle County" by Calkins. There are short descriptions of 131 lichens.

38. **Jordan, D. S.** The fur seal and Fur-Seal Islands. Part 3. I-XI. 1–629. *pl. 1–94.* Many figures partly unnumbered. Washington, D. C., Government printing office, 1899. On page 583 is a list of nine lichens determined by Calkins.

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CULTURES OF UREDINEAE IN 1912, 1913 AND 1914.[1]

J. C. Arthur

The present article is the thirteenth of a series of reports[2] by the writer upon the culture of plant rusts, beginning in 1899 and completing sixteen consecutive years. The work for the three years covered by the present report has been done under the auspices of the Indiana Experiment Station, as a part of a research project supported by the Adams Fund.

The heaviest part of the work each year falls in April and May, and during this time the regular staff of the botanical department of the Experiment Station is supplemented in order to take care of the largely increased routine part of the work. In 1912 the assistant for the culture work was Mr. L. O. Overholts, a senior student of Miami University, Ohio, recommended by Dr. Bruce Fink; in 1913 Mr. Ezra Levin, junior student with credits at the Agricultural College of Michigan, recommended by Dr. Ernst A. Bessey, was in charge; and in 1914 Mr. Carl B. Gibson, senior student of Wabash College, Indiana, recommended by Prof. H. W. Anderson, did the work.

A large number of correspondents have assisted as in previous years by sending culture material, often by supplying information from field observations, and sometimes by making special trips to secure additional material or search for cultural clues. To all such persons, and especially to those who have been to trouble and expense in response to the wishes of the writer for local aid, the most hearty thanks are accorded. Without the assistance of observers in the field, the work of studying the life histories of the rusts extending over the vast territory of North

[1] Presented before the Botanical Society of America at the Philadelphia meeting, December 29, 1914.

[2] See Bot. Gaz. **29**: 268–276; **35**: 10–23; Jour. Myc. **8**: 51–56; **10**: 8–21; **11**: 50–67; **12**: 11–27; **13**: 189–205; **14**: 7–26; Mycol. **1**: 225–256; **2**: 213–240; **4**: 7–33, 49–65.

America, many species of which are local, would proceed much more slowly.

An important aid in bringing together information regarding relationship of the rusts, and especially regarding obscure species, and in securing cultural material of critical forms, has been the excursions, often of considerable length, undertaken by the writer and members of his staff.

Early in April, 1912, Dr. F. D. Kern and the writer paid a visit to Auburn, Ala., where in company with Prof. F. E. Lloyd, field conditions of *Peridermium fusiforme* and *Puccinia angustatoides,* the latter on *Rynchospora,* were studied.

In the latter part of May, 1912, the writer and Mr. F. J. Pipal spent two days in LaGrange county on the northern border of Indiana, in a vain search for the alternate host of the *Carex* rust, *Puccinia vulpinoidis.*

An excursion on the last of May, 1912, was made to the coast of Maine by Mr. C. R. Orton and the writer. The localities visited were on the Isle au Haut, where the writer had found a number of imperfectly known rusts during several vacational sojourns. A station for the *Puccinia* on *Carex maritima* on Deer Isle was also visited. All previous observations had been made between July and October, and this long journey of over a thousand miles was for the purpose of seeking out probable aecial hosts under spring conditions. Upon the return journey, Mr. Orton stopped in Vermont and secured cultural material, especially forms on *Carex.*

Between June 17 and 20, 1912, the writer made observations in company with Dr. J. J. Davis about Madison, Wis., and northward.

From the middle of July to the middle of August, 1912, Dr. Kern and the writer traveled over a thousand miles through the high mountains of southern Colorado, going west through the middle of the state, and returning along the southern border. A week was spent in the wonderful valley at Ouray and some days at Pagosa Springs. Very helpful information was gleaned regarding grass rusts, and particularly of the leaf and stem forms which the older mycologists listed as *Puccinia graminis* and *P. rubigo-vera.*

WILLIAM WIRT CALKINS

Three weeks of August, 1913, were spent in company with Mr. H. C. Travelbee, in northern Michigan in the vicinity of Leland. Here very abundant field confirmation was obtained of the correctness of the 1913 spring culture work in associating *Puccinia vulpinoidis* with aecia on *Solidago,* and material was secured for repeating the work.

Two days were profitably given in November, 1913, accompanied by Dr. F. D. Fromme, to an exploration of the Kankakee marshes in northern Indiana, and as much time in December following, accompanied by Mr. C. A. Ludwig, to a reconnoissance about French Lick in southern Indiana.

During February and the early part of March, 1914, an extended trip by Dr. Fromme and the writer was made through the Southwest. Field work began at Denison, on the northern border of Texas. At Denton the localities made interesting to urediniologists by the extended field work of Mr. W. H. Long were visited. Stops on the way southward to Austin, and a divergence to Houston and Galveston, gave interesting results. Observations in the arid region were made principally at San Antonio and El Paso, Texas, the region about the Agricultural College, N. Mex., and at Douglas and Tucson, Ariz. At Tucson through the kindness and material assistance of Dr. D. T. MacDougal and his corps of investigators at the Desert Botanical Laboratory, the rust flora of the vicinity was examined, and a very important culture on *Brodiaea* was carried to completion.

The dominant ideas actuating the above mentioned geographical explorations are not so much those of the ordinary collector, to find new species, but rather those of the student, to secure additional knowledge of species already named but imperfectly known, and to gather facts bearing upon relationships.

To indicate the extent of the labor involved in securing the results recorded in this paper the following statistics are given. During the three seasons covered by this report, 380 collections with resting spores, and 68 with active spores were available, but scarcely one third of those with resting spores could be made to germinate. To test the germinating condition of the spores over 2500 drop cultures were made. Altogether 650 sowings were undertaken upon growing hosts and 84 infections obtained.

NEGATIVE RESULTS.—It has been customary in these reports to record failures to ascertain the alternate host, when sowings were made with spores known to be capable of germination and made upon plants that were in proper condition for infection. As the work progresses, and fewer species are left to be connected with alternate hosts, the need of such records diminishes, especially as more and more dependence is placed upon field observations for the clues to relationship. A few trials during the last three years with negative results appear to be sufficiently significant to be worthy of record at this time.

1. PUCCINIA MCCLATCHIEANA Diet. & Holw.—A collection of this species on *Scirpus microcarpus* (*S. rubrotinctus*), from Vaughns, Washington Co., N. Y., sent by Mr. Stewart H. Burnham, was used for sowings made April 1, 1914, on *Chelone glabra, Hydrophyllum virginicum, H. Fendleri, Actaea alba, Dirca palustris,* and *Iris versicolor,* all without infection.

This species has been confused with *Puccinia angustata* Peck. The name was first applied to a Californian collection thought to be on *Scirpus sylvaticus,* but now determined as *S. microcarpus.* It is a common species along the Pacific coast on the last named host, known in one instance as far into the mountains as Belgrade near Bozeman, in southwestern Montana. It also occurs along the Atlantic coast on the same host (usually called *S. rubrotinctus*), being known from Nova Scotia to Delaware, and inland as far as Albany, N. Y. It was a collection of this species and host that was cited by Peck in establishing his *Puccinia angustata,* as on "*Scirpus sylvaticum,*" from West Albany, N. Y. No clues to the identity of the alternate host have yet been secured.

2. PUCCINIA CRYPTANDRI Ellis & Barth.—A good teliosporic collection of this rust on *Sporobolus cryptandrus* was obtained by Dr. Fromme and the writer February 20, 1914, at Mesilla Park, N. Mex., and sown March 20 on *Sphaeralcea lobata, S. incana,* and *Callirhoe digitata.* Eight days later it was sown on other plants of *S. incana* and *C. digitata,* and on *Hibiscus militaris.* Again on March 9, it was sown on *Hydrophyllum Fendleri, Phacelia tanacetifolia, Thalictrum Fendleri,* and *Abronia umbellata.*

A collection similar to the last was obtained on the preceding day, but thought at the time to be *Puccinia tosta,* which was

sown April 17 on *Lithospermum officinale, Aesculus glabra, Eleagnus argentea, Lepargyraea canadensis,* and *Doellingeria umbellata.* It was sown again March 20 on *Sphaeralcea lobata, Callirhoe digitata* and *C. involucrata.* No infection was secured.

This is the first attempted culture of this species with teliospores, although once grown from amphispores.[3] Most collections show only the amphisporic stage of the rust. No clue to the alternate host has yet been obtained.

3. PUCCINIA EMACULATA Schw.—This exceedingly common rust on *Panicum capillare* has been used in previous years for sowings on 26 different species of hosts with no infection.[4] A careful morphological study shows that the species in its uredinial and telial conditions is very like *Puccinia Pammelii* Arth. (*P. Panici* Diet.), occurring commonly on *Panicum virgatum,* whose aecia have been grown upon *Euphorbia corollata.* Since this fact was ascertained, attempts have been made to grow *P. emaculata* upon *Euphorbia corollata.* Telial material from the vicinity of Lafayette, Ind., was sown accordingly on April 28, 1913, March 24, 31, and April 6, 1914. Material collected by Dr. Fromme at Lakehurst, N. J., was sown May 8, 1914, on both *E. corollata* and *E. cyparissias.* A collection from Lafayette was also sown March 31, 1914, on *Chelone glabra,* and *Dirca palustris,* which had not previously been tried. All attempts were equally fruitless. It is hoped that some time a fortunate field observation may lead to the solution of the problem.

4. UROMYCES RHYNCOSPORAE ELLIS.—No satisfactory field clues to the alternate host of this species have yet been obtained. Morphological study has led to the suggestion, improbable as it may seem at first, that it can belong to the very common *Carex-Aster-Solidago* complex. To test this suggestion, material obtained by Dr. Kern and the writer at Auburn, Ala., was sown April 22, 1912, on *Aster paniculatus, Solidago canadensis,* and *Helianthus angustifolius.* Another set of sowings was made on May 8 following upon other plants of the same three hosts, and on *Ruellia strepens,* and *Apocynum cannabinum.* No infection

[3] Jour. Myc. 14: 20. 1908.

[4] Bot. Gaz. 35: 12. 1903; Jour. Myc. 8: 52. 1902; 10: 10. 1904; 12: 12. 1906; 13: 192. 1907; 14: 11. 1908; and Mycol. 1: 230. 1909.

was obtained. Cultures were attempted on *Menyanthes* and *Decodon* in 1907, also without results.[5]

5. UROMYCES SPOROBOLI E. & E.—While on a visit to Mr. E. Bartholomew at Stockton, Kans., in August, 1911, the spot was pointed out where this rust on *Sporobolus longifolius* had been observed for several seasons following close upon a luxuriant development of an *Aecidium* on *Allium reticulatum,* as if the two might have genetic connection. Excellent material for testing the assumption was supplied the following spring, and a sowing was made April 29, 1912, upon *Allium reticulatum,* and also on *Malvastrum coccineum, Cassia chamaecrista, Baptisia bracteata, Apios tuberosa, Corydalis aurea, Zanthoxylum americanum, Physalis pubescens, Asclepias verticillata, Vagnera stellata,* and *Erigeron annuus,* all known to have aecia of uncertain connection, but without infection.[6]

SUCCESSFUL CULTURES SUPPLEMENTING PREVIOUS WORK.—The facts derived from growing the following species of rusts supplement those obtained from previous cultures in this series or from cultures recorded by other American or European investigators. In some cases the additional information recorded is of as great value as if it were entered under the next heading of cultures not before reported. For instance, the hitherto accredited species, *Puccinia vulpinoidea, P. Dulichii,* and *P. tosta,* are reduced to synonymy, and in so far simplify the naming of collections, beside permitting of a clearer conception of the variation of specific characters. A few cultures were made which are not reported, as they add no new facts to those already established.

CULTURES OF 1912

1. PUCCINIA GROSSULARIAE (Schum.) Lagerh.—The following successful cultures were made, all being sown on *Ribes Cynosbati.*

From *Carex pubescens,* Lafayette, Ind., sown April 20, showing pycnia April 29, and aecia May 9.

[5] Jour. Myc. 14: 12. 1908.

[6] For previous attempts see Bot. Gaz. 35: 11. 1903; and Mycol. 1: 13. 1912.

From *Carex crinita*, St. Anne de Bellevue, Quebec, sown May 8, showing pycnia May 16, and aecia May 24.
From *Carex arctata*, St. Anne de Bellevue, Quebec, sown May 8, showing pycnia May 22, and aecia May 27.
From *Carex tenuis*, St. Anne de Bellevue, Quebec, sown May 13, showing pycnia May 22, and aecia May 27.

In the report of cultures for 1910[7] the status of the name *P. albiperidia*, as representing a distinct species of *Carex-Ribes* rust, was discussed, but left somewhat unsettled. It was, however, thought to belong to a form possessing urediniospores with one basal pore, while the more common form on the same hosts, *P. Grossulariae*, has urediniospores with three equatorial pores. Subsequently Mr. C. R. Orton went over the material involved, including the type of *P. albiperidia*, and concluded[8] that this name should be a synonym of *P. Grossulariae*, and that the form having urediniospores with one basal pore is entitled to be considered a distinct species to which he gave the name *P. uniporula*, a species correlated with *Uromyces uniporulus* Kern, the aecia of both species being unknown.

To gather further information I have had single sori removed from the type collections of both species of *Puccinia* involved, and have had the spores of each sorus separately counted by using a mechanical stage. The results are given in the following table. The type of *P. albiperidia* is on wintered-over leaves, having been gathered April 30, 1901, at Lafayette, Ind., and provides few urediniospores, while that of *P. uniporula* was gathered August 20, 1910, at London, Ontario, and gives a fair number of urediniospores. Both types are on *Carex pubescens*. As usual when urediniospores are taken from mature telial sori, many of the spores are not in condition to show the pores. When the pores could not be ascertained with fair certainty, even after using lactic acid or chloral hydrate with iodine, the spores have been classed as uncertain. It was also necessary to take the number of cells in the teliospore into account, as *Carex pubescens* also bears *Uromyces uniporulus*, chiefly distinguishable by the teliospores.

[7] Mycol. 4: 13–15. 1912.
[8] Mycol. 4: 200, 201. 1912.

SPORES FROM TYPE COLLECTIONS OF *Puccinia albiperidia* and *P. uniporula*: EACH SORUS GIVEN SEPARATELY.

	Number of Sorus	Teliospores with 1-cell (*Uromyces*)	Teliospores with 2-cells (*Puccinia*)	Urediniospores with One Basal Pore	Urediniospores with Three Equatorial Pores	Uredinio-spores with Pores Uncertain
Puc. albiperidia	1	0	Not counted	0	0	0
	2	0	231	0	0	0
	3	0	317	0	0	0
	4	0	363	3	0	1
	5	0	886	4	0	2
	6	1	327	0	1?	4
	7	29	1325	0	0	3
	8	314	3	0	1?	0
	9	422	1	0	0	0
	10	697	2	0	0	1
	11	Not counted	0	0	0	0
Puc. uniporula	12	0	142	17	2	5
	13	3	853	4	1	5
	14	3	871	3	0	1
	15	4	1455	5	0	1
	16	5	19	12	1	7

Taking first the two columns of teliospores in the above table, it may be assumed that when a few only of either one- or two-celled teliospores occur in a sorus they are to be considered as incidental, possibly mesosporic. We may exclude from our present consideration four sori (8 to 11 incl.) from the type of *P. albiperidia,* as belonging to another species, *Uromyces uniporulus,* intermixed on the same leaf blades.

Of the remaining seven sori taken from the type of *P. albiperidia,* two of them (numbers 4 and 5) show a few urediniospores with one basal pore, and one sorus (number 6) shows one urediniospore with apparently three equatorial pores, while all others give no urediniospores whose pores could be made out with certainty.

Of the five sori (12 to 16 incl.) taken from the type of *P. uniporula* all show a number of urediniospores with one basal pore, and in addition three of the sori (numbers 12, 13, and 16) show urediniospores with three equatorial pores, as well as a number of spores whose pores could not be located. It is curious to note that in this type material of *P. uniporula* about one tenth of the urediniospores possess equatorial pores, and that these spores are intermixed in the same sori with the one-pored spores.

So far as the morphological evidence goes, there appears to be

no absolute difference between the types of *P. albiperidia* and *P. uniporula*. But *P. albiperidia* has been cultured on *Ribes,* producing aecia that can not be distinguished from those *Carex* rusts which show urediniospores with equatorial pores only. Whether aeciospores grown from *P. albiperidia* material would reproduce urediniospores, when sown back on a suitable *Carex,* with only three-pored or only one-pored urediniospores, or with sori containing a mixture of the two, is yet to be demonstrated. In the meantime, it seems best to use the name *P. albiperidia* as representing a form with aecia on *Ribes,* and synonymous with *P. Grossulariae,* while *P. uniporula* can be retained for such collections as show a preponderence of one-pored urediniospores. It is interesting to note in this connection that in Europe no *Carex* rust has yet been found agreeing with the uniporulate forms here discussed.

The essential specific unity of all *Carex-Ribes* rusts in both America and Europe was the conclusion reached by Dr. H. Klebahn in 1907. Dr. Klebahn's extended cultural work on this group of rusts began in 1892, and resulted in the separation of five species. In 1904 and 1906 he studied the behavior of American material grown from teliospores transmitted by the writer. Taking into account both European and American material, he came to the conclusion[9] that the six described species of *Carex-Ribes* rusts were biological forms of one collective species, for which he suggested the name, *Puccinia Ribesii-Caricis.* This conclusion is upheld by the above study, although an earlier name is preferred for the species.

2. PUCCINIA CARICIS-ASTERIS Arth. (*P. Caricis-Solidaginis* Arth.)—Five successful cultures of this rust were secured. They are as follows:

Teliospores from *Carex* sp., London, Ontario, sown April 10 on *Aster* sp., showing pycnia April 16, and aecia April 27.

Teliospores from *Carex* sp., Lafayette, Ind., sown April 11 on *Aster* sp., showing pycnia April 23, and aecia April 29.

Teliospores from *Carex retrorsa,* St. Anne de Bellevue, Quebec, sown May 14 on *Aster paniculatus,* showing pycnia May 22, and aecia May 27.

Teliospores from *Carex scoparia,* St. Anne de Bellevue, Quebec, sown May 13 on *Aster paniculatus,* showing pycnia May 22, and aecia

[9] Klebahn, Zeits. Pflanzenkr. 3: 134. 1907.

May 27; also sown same date on *Euthamia graminifolia,* showing pycnia May 22, at aecia June 4.

The significant thing about these cultures is that the material from *Carex scoparia,* which was sent by Mr. W. P. Fraser, grew on both *Aster* and *Euthamia*. The rust on this species of *Carex,* as represented in the herbarium, was for a long time considered sufficiently diverse morphologically to constitute a distinct species. Two years ago material on *Carex scoparia* from Maine was cultured on *Euthamia,*[10] but did not grow on *Aster paniculatus* or *Solidago canadensis*. This year sowings were made on the three hosts named and results obtained on two of them. It was pointed out in the discussion of the results two years ago that the *Aster-Solidago-Erigeron* group of *Carex* rusts probably constitutes a single species with a number of more or less defined races. The same view has been expressed elsewhere.[11] Numerous confirmatory facts of diverse nature have been accumulating, until it seems advisable to adjust the nomenclature to accord with present knowledge.

This species is one of the most common forms of rust in North America. It evidently is less abundant in South America and in the eastern hemisphere. The morphological study of similar European forms, rated as species, discloses some that undoubtedly are to be classed in the same category with the American group. Without taking space to record the evidence, the conclusion has been reached that the most available name for the American and European constituents of the species here represented, but possibly not the oldest one, is *Puccinia extensicola* Plowr. This name was founded on telial material from *Carex extensa,* obtained at Norfolk, England, and cultured on *Aster Tripoli,* and is in every way comparable with the *Carex-Aster* forms of America.[12]

3. PUCCINIA ANGUSTATA Peck.—Teliospores on *Scirpus atrovirens,* collected at Lafayette, Ind., by L. O. Overholts, were sown

[10] Mycol. 4: 15. 1912.

[11] Arthur, The physiologic aspect of the species question. Amer. Nat. 42: 246. 1908.

[12] For previous American cultures of this specific group, see Bot. Gaz. 35: 15, 21. 1903: Jour. Myc. 8: 53, 54. 1902; 11: 58. 1905: 12: 15. 1906; 14: 13. 1908; Mycol. 1: 233. 1909; 2: 224. 1910; and 4: 15, 16. 1912.

May 9 on *Lycopus americanus,* giving rise to pycnia May 16, and aecia May 24. Another collection believed to be the same rust and on the same host, collected at London, Ontario, by J. Dearness, was sown May 13 on *L. Americanus,* giving rise to pycnia May 20, and aecia May 27. Corresponding cultures have been made many times before.[13] The rust is very common throughout the eastern United States, especially northward, but has not been seen in the Rocky mountain region or on the Pacific coast. Professor Peck based the name, *Puccinia angustata,* which was published in the Bulletin of the Buffalo Society of Natural History, volume 1, page 67, July, 1873, upon material from "leaves of *Scirpus sylvaticum* and *S. Eriophorum;* West Albany and Watkins, September." Upon examination of type material, it transpires that the collection on "*S. sylvaticum*" was made at Watkins, N. Y., and that on *S. Eriophorum* at West Albany, N. Y., and furthermore, that of the two hosts cited only *S. Eriophorum,* collected at Watkins, N. Y., although the second one mentioned, bears teliospores that correspond to the description. The other collection on "*S. sylvaticum,*" found to be in reality *S. microcarpus* (*S. rubrotinctus*), bears a distinctly different form of teliospore, and must be considered to belong to some other species than *P. angustata.* The type of *P. angustata* Peck is, therefore, the collection in the herbarium of the New York State Museum, at Albany, N. Y., collected in September [1871?], at Watkins, N. Y., on *Scirpus Eriophorum,* by Prof. C. H. Peck. Thanks are due to Prof. Peck for the loan of the type material and for much assistance in ascertaining numerous facts connected therewith.

4. PUCCINIA ELLISIANA Thüm.—A collection on *Andropogon* sp., made by Dr. J. F. Brenckle, at Kulm, N. D., was used to sow, April 9, on *Viola cucullata, V. Nuttallii, V. primulaefolia, Laciniaria punctata* and *Lithospermum angustifolium,* with infection only on the two first named species of *Viola.* In both cases pycnia began to show in abundance May 8, and aecia May 12.

A number of vain attempts have been made in previous

[13] For previous cultures see Bot. Gaz. **29**: 273. 1900; Jour. Myc. **8**: 53. 1902; **11**: 58. 1905; **13**: 196. 1907; **14**: 14. 1908; Mycol. **1**: 234. 1909; **4**: 17 and 54. 1912.

years[14] to culture this rust, thirty-five species of hosts having been used other than those used this year. Only once was a plant of *Viola* used, *V. striata,* a caulescent species on which such aecia have not yet been found, and are not very likely to occur.

The successful cultures were inspired by field observations by Dr. Brenckle, who sent us material with which to test his prediction. In addition to Dr. Brenckle's opinion there was also at hand the opinion of Mr. C. R. Orton, at that time working on the rusts in my laboratory, which was drawn from a study of correlation between this species and *Uromyces pedatatus,* in a paper read December 28, 1911, but not published until later,[15] the latter species having its aecia on acaulescent violets. Since that time Mr. W. H. Long has published[16] extended studies, both cultural and morphological, with important bearings which can not be taken into consideration in this connection.

5. PUCCINIA STIPAE Arth.—Two collections with teliospores on *Stipa comata,* gathered by Mr. E. Bethel, from different spots at Boulder, Colo., were used for cultures. One was sown May 15 on *Senecio lugens, S. spartioides,*[17] *Chrysopsis villosus, Grindelia squarrosa, Gutierrezia Sarothrae,* and *Solidago mollis,* all considered probable hosts for the aecia. Infection occurred only on *Gutierrezia Sarothrae,* showing pycnia May 22, and aecia May 27, both in abundance.

The other collection was sown May 17 on the same set of hosts with infection only on *Senecio spartioides,* showing numerous pycnia May 23, and aecia June 1.

This species has previously been cultured[18] on *Aster multiflorus, A. ericoides, A. Novae-Angliae, Solidago canadensis, Grindelia squarrosa,* and *Senecio lugens.* The present study adds two

[14] See Jour. Myc. 14: 10. 1908; Mycol. 1: 231. 1909; 2: 220. 1910; and 4: 9. 1912.

[15] Mycol. 4: 199, 200. *pl. 70, figs. 5 and 6.* 1912.

[16] Notes on three species of rusts on *Andropogon,* Phytopath. 2: 164–171. August, 1912; and Influence of the host on the morphological characters of *Puccinia Ellisiana* and *Puccinia Andropogonis,* Jour. Agric. Research 2: 303–319. July, 1914.

[17] The same host that was erroneously called *S. Douglasii* in report for 1910. Mycol. 4: 9, 11. 1912.

[18] See Jour. Myc. 11: 63. 1905; and Mycol. 4: 19. 1912.

aecial hosts to the list previously known, and further strengthens the view that the species consists of a number of loosely defined races.

6. PUCCINIA AGROPYRI E. & E.—Three collections on *Elymus canadensis* from two widely separated and very different habitats were successfully cultured. One collection made by Mr. E. Bethel at Boulder, Colo., from plants on which he had previously placed leaves of *Clematis ligusticifolia* covered with aecia, brought from thirty miles distant, was sown April 27, on *Clematis ligusticifolia, C. Douglasii, Anemone cylindrica, Delphinium Geyeri,* and *Thalictrum Fendleri,* all believed to be probable hosts of this rust, and on *Phacelia heterophylla, Hydrophyllum capitatum, H. Fendleri,* and *Onosmodium occidentale,* which have been suspected from field observations to belong to the list of hosts. Infection only occurred on *Clematis ligusticifolia,* showing pycnia May 8, and aecia May 20.

Another collection by Mr. Bethel from plants growing with aecia-bearing *Clematis lingusticifolia,* at Boulder, Colo., was sown May 14, on the same nine species of hosts, with infection only on *Clematis ligusticifolia,* showing pycnia May 21, and aecia May 29.

The third collection by Dr. Brenckle from Kulm, N. Dak., was sown on *Clematis ligusticifolia, C. Douglasii, C. virginiana, Anemone cylindrica, Delphinium* sp. from Colorado, *Thalictrum Fendleri, T. alpinum, Aquilegia caerulea,* and *A. flavescens,* all belonging to a quite possible group of hosts, and on the outlying hosts, *Phacelia heterophylla, Hydrophyllum Fendleri, Onosmodium occidentale,* and *Elaeagnus argentea.* Infection was obtained only on *Anemone cylindrica,* showing a few pycnia May 20, but without maturing aecia.

Another collection of the same rust on *Agropyron Smithii* (host determined by Prof. A. S. Hitchcock), collected by the writer at Pueblo, Colo., was sown April 29, on *Clematis ligusticifolia, C. Douglasii, Anemone cylindrica, Delphinium* sp. from Colorado, *Thalictrum Fendleri, Hydrophyllum capitatum, H. Fendleri,* and *Onosmodium occidentale,* with infection only on the first named. The pycnia began to show May 8 and aecia May 17.

Cultures from *Elymus* on *Clematis ligusticifolia* are now reported for the first time. It has seemed quite probable from field observations that the aecia occurring on this host in great abundance throughout the Rocky Mountains were probably connected with telia on other hosts than *Agropyron,* where they have usually been assigned in this country and Europe, but this is the first direct proof by cultures. In 1904 a rust on *Bromus* from Iowa, Indiana, and Wisconsin, believed to be *Puccinia tomipara* Trel., was grown on *Clematis virginiana.* In a discussion of the results[19] it was considered that the aecia were the form known as *Aecid. Clematitis* Schw., and distinct from the form in the Rocky Mountains, going to telia on *Agropyron.* The latter form, called *Aecid. Clematidis* DC., was grown in 1907[20] from Rocky Mountain material on *Agropyron,* but on the eastern host *C. virginiana,* no plants of *C. ligusticifolia* being available at the time. This was considered a demonstration that the form known and cultured in Europe as *P. Agropyri* E. & E., on *Agropyron,* is identical with the western form, but distinct from the eastern *Bromus-Clematis* rust.

In 1908 a rust on *Bromus* from the Rocky Mountains was grown on *Thalictrum dioicum* with success. The same season a similar subepidermal rust on *Agropyron* from the western mountains was grown on *Aquilegia.* These two forms were considered to represent distinct species and were named respectively *Puccinia alternans* and *P. obliterata.*[21]

The first cultural study of this group of subepidermal rusts began in 1903 with a supposed culture of *Dirca aecia* on *Bromus,*[22] an error which was rectified in the report of cultures the year following. From that time to the present morphological studies, field observations, and careful cultures have multiplied until now there seems to be no further doubt that this group of subepidermal forms, passing under various names, represents only one species, but a species broken up into a number of races of considerable

[19] Jour. Myc. 11: 62–63. 1905; also 13: 197. 1907; and Mycol. 1: 236. 1909.

[20] Jour. Myc. 14: 15. 1908.

[21] Mycol. 1: 248–251. 1909; also 2: 225. 1910.

[22] Jour. Myc. 10: 19. 1904; also 11: 62. 1905.

fixity. The telia are on *Agropyron, Elymus,* and *Bromus* chiefly and the aecia on *Clematis, Thalictrum, Aquilegia, Anemone,* and probably other Ranunculaceous hosts, and possibly on some hosts of other families.

7. PUCCINIA MONOICA (Peck) Arth.—In the report of cultures for 1911[23] record was made of sowings of teliospores from *Trisetum subspicatum* made June 20 upon two plants of *Arabis* (grown from Colorado seed), one plant of which indicated infection by a pathological change into a glomerate mass of rosettes, somewhat paler than normal. In this condition the plant passed the winter. Early in spring it began to send up a half dozen or more shoots instead of the usual single shoot of normal plants. Pycnia first were seen March 23, 1912, scattered over the considerably drawn shoots. Before there was time for the aecia to mature the plant accidentally died.

Freshly gathered plants of an *Arabis* bearing aecia, obtained May 13 at Palmer Lake, Colo., were received from Mr. Bethel, and aeciospores from them sown May 18 on leaves of *Koeleria cristata* and *Trisetum subspicatum*. Infection occurred only on the *Koeleria,* uredinia first being noticed June 18, and telia June 24.

There is no present need of adding to the general discussion of this species given in the last report of cultures.[24] We have now grown the rust from both aeciospores and teliospores, and shown that it occurs on both *Trisetum* and *Koeleria,* with some indication of biological races.

8. UROMYCES PERIGYNIUS Halst.—A collection on *Carex intumescens,* made by Dr. Charles E. Fairman at Lyndonville, N. Y., was sown April 24, on *Aster paniculatus, Solidago canadensis, Erigeron annuus, Euthamia graminifolia,* and *Onagra biennis.* On May 7 pycnia began to show in great abundance on the *Aster,* followed on May 10 by aecia. On the *Solidago* a few pycnia appeared May 8, but no aecia developed, although the host plant was in good condition.

In former cultures[25] material on this host from Nova Scotia produced infection on *Aster,* but not on *Solidago.* Material on

[23] Mycol. 4: 60. 1912.

[24] Mycol. 4: 59. 1912.

[25] See Jour. Myc. 10: 15–17. 1904; Mycol. 4: 21, 22. 1912.

other hosts from Maine and Indiana produced strong infection on *Solidago,* and in one case a sparing infection also on *Aster.* In the first culture report on the species, the close resemblance between this species and the parallel form under *Puccinia,* that we are now calling *P. extensicola,* was pointed out, and in the second report the evidence of well defined biological races was adduced. Both of these points are further emphasized by the cultures here reported.

In this connection an error should be corrected in the report of cultures for 1910. Quite anomalous results[26] were obtained in that year by sowing material of *Puccinia quadriporula* Arth. from *Carex Goodenowii* from the type locality, upon *Aster paniculatus.* It was at that time pointed out that the resulting aecia were indistinguishable from those of *P. Caricis-Asteris* Arth. A careful re-examination of the culture records has revealed the fact that the sowing on April 26, 1910,[27] was immediately preceded by a very successful sowing of *Uromyces perigynius* on another plant of the same species of *Aster.* The inference is that the supposed result from the spores of *P. quadriporula* in reality came from stray spores of *U. perigynius* accidentally intermixed during the operation, and do not represent a culture of *P. quadriporula.*

Furthermore, a careful and extended morphological study of a number of collections of *P. quadriporula,* made in different years from the type locality and its vicinity, leave no doubt that the form should be placed under *P. Grossulariae,* a *Carex* rust having aecia on *Ribes.* The four-pored feature of the urediniospore, from which the name is derived, is found to be no more marked than in some other collections proven to be a part of that species.

9. UROMYCES JUNCI (Desm.) Tul.—It was stated in the report of cultures for 1910[28] that both Mr. Bethel and Dr. Brenckle held the opinion that this species in some one of its forms would be found to have aecia on *Ambrosia psilostachya.* Both gentlemen provided material for a test the present season, which verified their prediction, as the following record of cultures shows. The telial host in each instance was *Juncus balticus.*

[26] Mycol. 4: 28. 1912.
[27] Mycol. 4: 21. 1912.
[28] Mycol. 4: 23. 1912.

Telia from	Prediction for Aecia	Date of Sowing	Host for Culture	First Pycnia	First Aecia
North Dakota ...	*Carduus*	April 22	*Carduus Flodmanii*	May 7	May 12
			Ambrosia psilostachya	——	——
Colorado	*Ambrosia*	April 23	*Ambrosia psilostachya*	May 8	May 12
			Ambrosia trifida	May 8	——
			Carduus Flodmanii	——	——
Montana	....	May 6	*Ambrosia psilostachya*	——	——
			Ambrosia trifida	——	——
			Carduus Flodmanii	May 16	May 21
North Dakota ...	*Ambrosia*	May 11	*Ambrosia psilostachya*	——	——
			Ambrosia artemisiaefolia	May 22	May 27
			Ambrosia trifida	——	——
			Carduus Flodmanii	May 20	May 27
			Silphium perfoliatum	——	——
			Laciniaria scariosa	——	——
			Xanthium canadense	——	——
North Dakota ...	*Ambrosia*	May 11	*Ambrosia psilostachya*	May 27	——
			Ambrosia trifida	——	——
			Xanthium canadense	——	——

The three collections sent by Dr. Brenckle from Kulm, N. Dak., bore out the prediction that he had based upon field observations. One of the collections grew upon both *Ambrosia* and *Carduus*, indicating that the races are not invariably fixed. The collection sent by Mr. Bethel from Boulder, Colo., also bore out the prediction which he had based on a field observation. No suggestions came with the collection sent by Mr. Vasku from Nihill, Mont. As stated in the North American Flora (7: 238. 1912), only *Carduus* has heretofore been proven by cultures in this country to be a host to this species, although both *Ambrosia* and *Arnica* have been considered to be hosts, a conclusion derived from morphological and field studies.[29]

10. UROMYCES ACUMINATUS Arth.—A collection made by Mr. Bethel at Boulder, Colo., on *Spartina Michauxiana*, showing the characteristic slender, acuminate teliospores to which this name has been applied, was suspected from field observations to belong to aecia found on *Collomia*. Sowings were made April 29 on *Collomia linearis*, *Steironema ciliatum* and *S. lanceolatum*. Infection resulted only on *Collomia*, showing a great abundance of pycnia May 8, and aecia May 12.

This culture adds one more host experimentally proven to belong to this species, although it had been associated with the spe-

[29] For previous cultures see Jour. Myc. 14: 12. 1908; Mycol. 2: 220. 1910; 4: 22. 1912.

cies and with this particular race from morphological and field studies.[30]

11. GYMNOSPORANGIUM NELSONI Arth. (*G. durum* Kern).—Galls of this rust a half inch in diameter from *Juniperus scopulorum,* gathered by Mr. Bethel at Cimarron, Colo., were used for sowing May 25 on *Amelanchier canadensis* and *Crataegus punctatus.* Infection occurred only on *Amelanchier,* showing abundant pycnia June 4, but giving only a few aecia, first noticed July 17.[31]

12. GYMNOSPORANGIUM BETHELI Kern.—A collection of galls on small branches of *Juniperus scopulorum,* made by Mr. Bethel at Plainview, Colo., were used to sow, June 4, on *Crataegus Pringlei,* giving rise to pycnia June 14, and aecia July 17.[32]

13. GYMNOSPORANGIUM GRACILENS (Peck) Kern & Bethel.—A collection on *Juniperus utahensis,* made by Mr. Bethel at Glenwood Springs, Colo., was used for sowing on *Philadelphus coronarius,* giving an abundance of pycnia May 31, and aecia June 14. Another sowing was made at the same time on a horticultural form closely related to *P. coronarius,* imported from France, *P. Keteleerii,* which resulted in a luxuriant growth of pycnia May 30, and aecia June 22. These results confirm previous work.[33]

CULTURES OF 1913

14. PUCCINIA ALBIPERIDIA Arth.—A collection made by Mr. L. S. Orton at Walden, Vt., on a narrow-leaved *Carex,* and communicated by Mr. C. R. Orton, was used to sow, May 29, on *Ribes Cynosbati,* giving abundant infection with pycnia showing June 6, and aecia June 20. The rust was labelled by Mr. Orton *P. uniporula,* and our examination confirms this view, many urediniospores having been seen with one basal pore and none with equatorial pores. This does not, however, preclude the possibility of the infection coming from the three-pored form, which may be intermixed with the other, and the species is listed accordingly

[30] See North American Flora 7: 231. 1912. For previous cultures see Mycol. 4: 29. 1912; also Fraser in Mycol. 4: 186. 1912.

[31] For previous cultures see Mycol. 4: 61. 1912.

[32] For previous cultures see Jour. Myc. 14: 23. 1908; Mycol. 1: 240. 1909; 2: 230. 1910; 4: 25. 1912.

[33] For previous cultures see Mycol. 4: 63. 1912.

as in the similar culture work of 1912, discussed above under number 1.

15. PUCCINIA VULPINOIDIS D. & H.—A collection of this rust on *Carex vulpinoidea* (host determined by Dr. Theo. Holm) made by Mr. Overholts at Elkton, Ohio, was used to sow April 17 on *Aster paniculatus, A. Drummondii, Solidago canadensis, S. glaberrima* (*S. missouriensis* of most manuals), *S. Rugosa,* and *S. mollis.* There was no infection of *Asters,* but a most abundant infection of the four species of *Solidago,* pycnia showing in each case April 27, and aecia May 7.

Puccinia vulpinoidis has been considered a distinctive and easily recognized species on account of the covered telial sori. A careful morphological study, chiefly by Dr. F. D. Kern, had shown however, that aside from this character the spore structure and range of hosts agree with *P. Caricis-Solidaginis,* or as we now say, *P. extensicola,* and to this morphological study was due the suggestion which led to the above successful cultures. The permanently covered telial sorus must be considered in the light of this study to be associated with the structural peculiarities of the host, and not a character to be used without qualification.

16. GYMNOSPORANGIUM CLAVARIAEFORME (Jacq.) DC.—Material on *Juniperus sibirica,* sent by Mr. Bethel from Tolland, Colo., was sown May 21 on *Crataegus cerronus* and gave rise to abundant pycnia June 1, but no aecia matured.[34]

17. PERIDERMIUM FUSIFORME Arth. & Kern.—Through the kindness of Dr. F. A. Wolf of Auburn, Ala., typical material of this striking rust was received, gathered from a grove of *Pinus taeda,* which Dr. Kern and myself had visited in April, 1912, and in which this form of *Peridermium* is very abundant.

The first collection, sent March 22, 1913, was from a main stem an inch in diameter, the fusiform gall being one and a half inches in diameter at the middle, and six inches long. It was sown March 24 on two plants of *Quercus rubra.* Uredinia began to appear sparingly on one plant by April 3, but failed to appear on the other, although telia developed on both plants April 14, in ample and perfect development.

[34] For previous cultures see Jour. Myc. 14: 19. 1908; Mycol. 1: 239. 1909; 4: 24. 1912; and 4: 56. 1912.

The second consignment was received April 5, 1913, consisting of a much larger gall, three inches in diameter by six inches long, but less typical in appearance. This material was sown April 6 on *Quercus rubra* and *Q. Phellos*. On the former, uredinia began to appear April 14, and on the latter April 18, followed by telia in both cases April 28.

This result shows without question that the form known under the name of *Peridermium fusiforme* is identical specifically with *P. Cerebrum*, both being the aecial stage of *Cronartium Quercus*. This cultural result is briefly referred to by Dr. Kern in Mycologia 6: 112, 135. 1914. The non-appearance of the repeating stage in one case is an interesting phenomenon apparently connected with some condition of the host.

18. PERIDERMIUM CARNEUM (Bosc) Seym. & Earle.—Leaves of *Pinus taeda* bearing this rust were gathered by Prof. P. H. Rolfs, at Gainesville, Fla., February 12, 1913, and two days later were used by use to make a sowing on *Vernonia fasciculata*. Uredinia began to appear in abundance on March 3. Another collection of the rust was gathered by Mr. H. E. Stevens from *Pinus palustris* in the vicinity of Gainesville, Fla., on March 1. This material was from small plants in the open, over which leaves of *Ipomoea pandurata* well covered with *Coleosporium Ipomoeae* had been placed the previous fall. The field condition appeared to warrant the inference that the pine aecia were derived from the *Ipomoea* telia. A sowing of the material was made March 10 on *Vernonia fasciculata*, but no plants of *Ipomoea* were available for a culture. Uredinia appeared on the *Vernonia* in abundance on March 29, and in the typical form of *Coleosporium Vernoniae*.

This result does not preclude the possibility that *Coleosporium Ipomoeae* is a form of *C. Vernoniae*, but judging from the microscopic appearance of the urediniospores, that species is more likely to be a form of *C. Solidaginis* than of *C. Vernoniae*.

CULTURES IN 1914

19. PUCCINIA EXTENSICOLA Plowr.—A collection of the form known as *P. vulpinoidis*, collected by Mr. Travelbee and the writer

on *Carex vulpinoidea,* at Leland, Mich., Aug. 26, 1913, was used to sow April 2, on *Solidago canadensis* and *Aster paniculatus.* Abundant infection occurred on the *Solidago,* pycnia showing April 11, and aecia April 20, but the *Aster* remained free. The collectors found in many instances old aecia on *S. canadensis* in the field, intermixed with rusted *Carex vulpinoidea.* The inference from field observation, and also the cultural work of last year as recorded above under number 15, is confirmed by the culture.

A collection of *P. Dulichii* Syd., on *Dulichium arundinaceum,* gathered Jan. 17, 1914, at Gainesville, Fla., by Mr. H. E. Stevens, was accompanied by young aecia on a species of *Aster.* This association suggested that they might be genetically connected. A sowing from the *Dulichium* material was made, Jan. 22, on *Aster Drummondii, A. paniculatus,* and on an undetermined *Aster,* which had been obtained from a field near New Orleans, La., also on *Solidago canadensis* and *Senecio obovatus.* Another sowing from the same material was made, Jan. 31, on the same three species of *Aster,* and on *A. Tweedyi.* The only infection was a sparing production of pycnia on *Solidago canadensis,* showing Feb. 3, which did not continue into aecia. As soon as this result was noticed, another sowing from the same material was made, Feb. 4, on *Solidago canadensis,* which resulted in an abundant infection, showing pycnia Feb. 16, and aecia Feb. 25. From this result, together with a careful microscopic study of herbarium material, it is inferred that *P. Dulichii* is a part of the common *P. extensicola,* although the telial host is not a *Carex.* It is the first time that any Carex rust has been traced to a telial host outside of the genus *Carex.*

20. PUCCINIA TOSTA Arth.—A collection was made by Dr. Fromme and the writer at Mesilla Park, N. Mex., on what was thought at the time to be *Muhlenbergia Porteri,* but which later proved to be the very similar appearing *Sporobolus asperifolius.* Thinking that it was *P. Muhlenbergiae,* known to have its aecia on malvaceous hosts, it was sown, March 20, on *Callirhoe involucrata, C. digitata,* and *Sphaeralcea incana.* Infection was obtained only on the last host, pycnia showing March 27, and aecia April 3, both in great profusion. Another sowing was at once

made of the same material on *S. lobata, C. digitata, Hibiscus militaris,* and *Malvastrum coccineum,* with infection only on the *Sphaeralcea,* pycnia showing April 6, but the aecia being destroyed by aphis before maturing.

Another collection of identical appearance was made five days later than the one above, at Ysleta, Texas, a few miles from El Paso. This was sown, March 28, on two plants of *S. lobata,* on *C. digitata,* and *H. militaris.* Both plants of *Sphaeralcea* gave infection, showing pycnia April 6, but resulting in few aecia, owing to accident. Another sowing from the same collection was made, May 2, on *Napaea dioica,* without infection.

Putting the above cultural results from *P. tosta,* with the gross appearance and subsequent microscopic study, and comparing with similar data from *P. Muhlenbergiae,* there appears to be no ground upon which to keep the two forms separate. The fact that the telial hosts belong to two genera of grasses is not in this case a difference of importance, as *Sporobolus* and *Muhlenbergia* intergrade, and are kept separate upon technical grounds. The previous cultural studies[35] of *P. Muhlenbergiae* have indicated that the species is a complex of races. It has been grown on *Hibiscus militaris* and *Callirhoe involucrata,* but the similar aecia on *Napaea, Malvastrum,* and *Sidalcea* have not yet been grown, although attempted, the failure believed to be due to a lack of the proper racial telia. The above is the first successful culture with material on *Sporobolus,* although previous attempts[36] have been made.

Hereafter it will be considered advisable to treat *P. tosta* as a synonym of *P. Muhlenbergiae.*

21. PUCCINIA AGROPYRI E. & E.—A collection of this rust on *Elymus virginicus* was made by Dr. Fromme and the writer on Feb. 13, 1914, at Austin, Texas, and at the same time the observation was made that *Clematis Drummondii,* not then in leaf, was in the same spot, and abundant in the vicinity. Dormant roots of this wild Clematis were secured, and later grown for the culture work.

[35] See Jour. Myc. 11: 51. 1905; 13: 192. 1907; Mycol. 1: 251. 1909; 2: 226. 1910; and 4: 18. 1912.

[36] See Jour. Myc. 10: 10. 1904; 12: 12. 1906; Mycol. 4: 10 and 52. 1912.

A sowing of telia was made April 1 on *Clematis Drummondii, C. Douglasii, C. virginiana, Aquilegia flavescens, A. canadensis, Thalictrum Fendleri,* and *T. dioicum.* Abundant infection occurred on the first named host, but on no others, pycnia appearing April 5, and aecia April 18.

The results are in accord with the cultures of 1912, reported above under number 6, but indicate another race not met with before.

22. UROMYCES PERIGYNIUS Halst.—A collection of this species on *Carex tribuloides* made at French Lick, Ind., by Mr. Ludwig and the writer, was sown April 1 on *Aster paniculatus, A. Drummondii, A. Tweedyi, Solidago canadensis, S. rugosa,* and *Euthamia graminifolia.* Infection was secured only on *Aster Tweedyi,* and then so sparingly that it was overlooked until April 8, when the aecia were observed. Cultures for 1912 are reported above under number 8.

This species of rust from other *Carex* hosts has previously been been grown[37] on two other species of *Aster,* and five species of *Solidago.*

23. UROMYCES SCIRPI (Cast.) Burr.— Material on *Scirpus fluviatilis,* sent by Mr. E. T. Bartholomew from Madison, Wis., was sown April 22 on *Sium cicutaefolium,* giving rise to a few pycnia May 5, but without further development. Another similar sowing April 24 gave rise to an abundance of pycnia May 5, and aecia May 11.

The former cultures[38] with American material have been on *Cicuta maculata.*

24. GYMNOSPORANGIUM NIDUS-AVIS Thax.—Telial material on *Juniperus virginiana,* gathered by Dr. Fromme at Woods Hole, Mass., was sown May 11 on *Amelanchier vulgaris,* giving rise to pycnia May 19, and a great abundance of aecia June 20.[39]

25. GYMNOSPORANGIUM BOTRYAPITES (Schw.) Kern.—Telial material on *Chamaecyparis thyoides* sent by Dr. Fromme from Lakehurst, N. J., was sown May 6 on the leaves of *Amelanchier canadensis* and *Aronia arbutifolia,* with no infection on *Aronia,*

[37] Jour. Myc. 10: 15. 1904; and Mycol. 4: 32. 1912.

[38] Jour. Myc. 13: 199. 1907; 14: 17. 1908; and Mycol. 1: 237. 1909.

[39] For previous cultures see Jour. Myc. 14: 19. 1908; Mycol. 2: 230. 1910; 4: 25 and 56. 1912.

but very abundant infection on *Amelanchier,* giving pycnia May 18, and aecia October 1.

Another collection on the same host was sent by Dr. Fromme four days later from Woods Hole, Mass., and sown May 11 on leaves of *Amelanchier canadensis,* giving pycnia June 5, and aecia October 27. The results are in accord with previous cultures.[40]

26. COLEOSPORIUM VERNONIAE B. & C.—A collection of *Peridermium carneum* on *Pinus taeda,* gathered at East Lake, Fla., by Mr. H. E. Stevens, was sown April 13 on *Aster paniculatus, Solidago canadensis, Euthamia graminifolia, Laciniaria punctata, L. Langloisii* (the plant obtained from Texas), and *Vernonia fasciculata.* A sparing infection was obtained on the *Vernonia* only, uredinia being first noticed May 8.

A similar collection sent by the same collector from Gainesville, Fla., was sown May 8 on *Solidago canadensis, Laciniaria Langloisii, Elephantopus carolinianus, Amsonia salicifolia,* and *Vernonia fasciculata.* Although all the hosts used were possible hosts for such a *Peridermium,* yet infection only occurred on the *Vernonia,* showing uredinia May 25 in abundance.

Uredinia from the last culture was sown May 17 on another plant of *Vernonia fasciculata,* with abundant infection, showing uredinia May 26. Another sowing from the same source was made May 28 on *Aster paniculatus* and *Laciniaria Langloisii,* with no infection.

The results are in accord with previous cultures,[41] and add but little to our knowledge of the numerous southern species of *Coleosporium.*

SUCCESSFUL CULTURES REPORTED NOW FOR THE FIRST TIME: The following species have never before been cultivated, in America or elsewhere, so far as the writer knows. Some of those included in the above list, such as *Puccinia vulpinoidis, P. Dulichii, P. tosta,* and *Peridermium fusiforme,* might with some propriety have been placed here, as not till after the cultures were made was their true status as species known.

[40] Mycol. 1: 240. 1909.

[41] Mycol. 4: 29 and 57. 1912.

CULTURES IN 1913

1. UROMYCES ELEGANS (B. & C.) Lagerh.—This autoecious rust, very common in the Southern States, is one of the group of species which produce no uredinia, so far as known, very few of which have been cultivated. Growing plants of *Trifolium carolinianum* bearing aecia were sent by Dr. F. A. Wolf from Auburn, Ala., and the aeciospores sown March 29 on plants free from the fungus. Teliospores began to appear about April 18 as the result.

This result does not disclose whether the species possesses both primary and secondary aecia, or whether pycnia ever occur. A culture with teliospores should be kept in view.

CULTURES IN 1914

2. PUCCINIA NODOSA Ell. & Hark.—While upon a visit to the Desert Botanical Laboratory at Tucson, Ariz., an exceptional opportunity was offered to study the life history of another autoecious species of rust, which like the one last mentioned, possesses no uredinia. A strong plant of *Brodiaea pauciflora,* growing near the door of the laboratory was moistened on February 26, sprinkled with aeciospores brought from some distance, and covered with a belljar. The temperature at the time was favorable for infection, the belljar being shielded from the direct rays of the sun. The experiment was left in charge of Dr. W. A. Cannon of the Laboratory staff, who kindly forwarded the leaves on March 18, when the sori first opened. Only telia were produced.

As in the preceding case the possibility of both primary and secondary aecia occurring in the life cycle is not touched upon.

3. PUCCINIA SPLENDENS Vize.—Through the courtesy of the Desert Botanical Laboratory, Dr. Fromme and the writer were enabled to make an excursion on February 28 to the Santa Rita Mountains in the vicinity of Tucson, Ariz., where we secured teliosporic specimens of *P. splendens* on *Hymenoclea monogyra.* Through the kindness of Prof. J. J. Thornber of the University of Arizona we received after our return to Indiana a number of thrifty young plants of this host, which soon started into leaf in the green house. A sowing of teliospores was made April 7,

and another April 15, with no result. A third sowing on April 25 was better done, and gave rise to pycnia on the leaves May 6, and aecia May 20.

Aeciospores from this culture were sown May 26, which resulted in the production of uredinia June 15, not numerous but well formed. Uredinia continued to be produced until they were finally followed sparingly by telia July 10.

In every sowing an abundance of spores was used, which were applied to both leaves and stems. Tests of the spores showed unusually strong germination. Why the infection was so sparing and only on the leaves, while in the field the rust is chiefly on the stems, was not apparent. The cultures supply a knowledge of the pycnia and uredinia, neither of which were before known.

4. PUCCINIA MINUTISSIMA Arth.—Viable material of this species on *Carex filiformis* was secured at much labor especially for this work by Mr. J. Dearness of London, Ontario, from the southeastern shore of Lake Huron. A collection made in December, 1911, was sown the following spring on seven hosts of as many genera without infection. Another collection of May, 1912, was similarly tested, and even more thoroughly, without success. A collection made in November, 1913, was sown April 18, 1914, on *Decodon verticillatus,* with an abundant infection, showing pycnia April 27, and aecia May 7.

The first suggestion for this connection was made by Prof. James B. Pollock of the University of Michigan, who wrote on August 3, 1909, as follows: "I found a rust on a patch of *Carex filiformis,* forming a half circle with a radius of about two rods around a specimen of *Decodon verticillatus,* some of whose leaves had an *Aecidium* on them. I send herewith specimens of both. No other *Aecidium* was found near the rusted sedge. The whole situation seems to me to indicate very closely the Decodon plant as a center of infection for the *Carex* rust."

The aecial stage of this rust is *Aecidium Nesaeae* Ger., but *Puccinia Nesaeae* Ellis & Ev. does not belong here, having been founded on a telial collection with the host erroneously determined. The error was detected by Prof. E. W. D. Holway.

5. GYMNOSPORANGIUM ELLISII (Berk.) Farl.—Material on *Chamaecyparis thyoides* was sent by Dr. Fromme from Lakehurst

N. J., and sown May 6 on *Myrica cerifera,* giving rise to pycnia May 15, and aecia June 6. This most interesting result was in accord with field observations made by Dr. Fromme, who has recorded the steps which led to the inference of relationship, and has also discussed the results, in a paper[42] anticipating this report.

The aecia of this species are of the aecidioid form, and not roestelioid, as in the majority of the species of the genus. Moreover, the host belongs to a family more divergent from the Malaceae, which bears most of the Gymnosporangial aecia, than heretofore supposed to be possible. The telial stage was once made the basis of a separate genus, *Hamaspora,* on account of the slender, more than two-celled teliospores. Completing a knowledge of the life history of a species with so many outlying characters is an especially notable achievement.

SUMMARY

The following is a complete list of the successful cultures made during the years 1912, 1913, and 1914. It is divided into two series, species that have previously been grown in cultures and reported by the writer or other investigators, and species whose culture is now reported for the first time.

A. SPECIES PREVIOUSLY REPORTED

1, (8) and 14. PUCCINIA GROSSULARIAE (Schum.) Lagerh. (*P. albiperidia* Arth., *P. quadriporula* Arth.)—Teliospores from *Carex arctata* Boott, *C. crinita* Lam., *C. pubescens* Muhl., and *C. tenuis* Rudge, sown on *Ribes Cynosbati* L.

2, 15 and 19. PUCCINIA EXTENSICOLA Plowr. (*P. Caricis-Asteris* Arth., *P. Caricis-Solidaginis* Arth., *P. vulpinoidis* D. & H., *P. Dulichii* Syd.).—Teliospores from *Carex retrorsa* Schw., sown on *Aster paniculatus* Lam.; from *Carex scoparia* Schk., sown on *A. paniculatus* Lam. and *Euthamia graminifolia* (L.) Nutt.; from *Carex vulpinoidea* Michx., sown on *Solidago canadensis* L., *S. glaberrima Martens, S. rugosa Mill.* and *S. mollis* Barth.; from *Dulichium arundinaceum* (L.) Britt., sown on *Solidago canadensis* L.

[42] Fromme, D. A. A new Gymnosporangial connection. Mycol. 6: 226–230. 1914.

3. PUCCINIA ANGUSTATA Peck.—Teliospores from *Scirpus atrovirens* Muhl., sown on *Lycopus americanus* Muhl.

4. PUCCINIA ELLISIANA Thüm.—Teliospores from *Andropogon* sp., sown on *Viola cucullata* Ait. and *V. Nuttallii* Pursh.

5. PUCCINIA STIPAE Arth.—Teliospores from *Stipa comata* Trin. & Rupr., sown on *Gutierrezia Sarothrae* (Pursh) B. & R., and *Senecio spartioides* T. & G.

6 and 21. PUCCINIA AGROPYRI E. & E.—Teliospores from *Elymus canadensis* L., sown on *Clematis ligusticifolia* Nutt., and *Anemone cylindrica* A. Gray; from *Elymus virginicus* L., sown on *Clematis Drummondii* T. & G.; and from *Agropyron Smithii* Rydb., sown on *Clematis ligusticifolia* Nutt.

7. PUCCINIA MONOICA (Peck) Arth.—Teliospores from *Trisetum subspicatum* (L.) Beauv., sown on *Arabis* sp., and aeciospores from *Arabis* sp., sown on *Koeleria cristata* (L.) Pers.

20. PUCCINIA MUHLENBERGIAE A. & H. (P. *tosta* Arth.).—Teliospores from *Sporobolus asperifolius* (Nees & Meyen) Thurb. sown on *Spaeralcea incana* Torr. and *S. lobata* Wooton.

8 and 22. UROMYCES PERIGYNIUS Halst.—Teliospores from *Carex intumescens* Rudge, sown on *Aster paniculatus* Lam., and *Solidago canadensis* L.; from *Carex tribuloides* Wahl., sown on *Aster Tweedyi* Rydb.

9. UROMYCES JUNCI (Desm.) Tul.—Teliospores from *Juncus balticus* Willd., sown on *Ambrosia psilostachya* DC., *A. trifida* L., and *Carduus Flodmanni* Rydb.

10. UROMYCES ACUMINATUS Arth.—Teliospores on *Spartina Michauxiana* A. S. Hitch., sown on *Collomia linearis* Nutt.

23. UROMYCES SCIRPI (Cast.) Burr.—Teliospores from *Scirpus fluviatilis* (Torr.) A. Gray, sown on *Sium cicutaefolium* Schrank.

11. GYMNOSPORANGIUM NELSONI Arth. (*G. durum* Kern).—Teliospores from *Juniperus scopulorum* Sarg., sown on *Amelanchier canadensis* (L.) Medic.

12. GYMNOSPORANGIUM BETHELI Kern.—Teliospores from *Juniperus scopulorum* Sarg., sown on *Crataegus Pringlei* Sarg.

13. GYMNOSPORANGIUM GRACILENS (Peck) Kern & Bethel.—Teliospores from *Juniperus utahensis* (Engelm.) Lemmon, sown on *Philadelphus coronarius* L. and *P. Keteleerii* Carr.

16. GYMNOSPORANGIUM CLAVARIAEFORME (Jacq.) DC.—Telio-

spores from *Juniperus sibirica* Burgsd., sown on *Crataegus cerronus* A. Nels.

24. GYMNOSPORANGIUM NIDUS-AVIS Thax.—Teliospores from *Juniperus virginiana* L., sown on *Amelanchier vulgaris* Moench.

25. GYMNOSPORANGIUM BOTRYAPITES (Schw.) Kern.—Teliospores from *Chamaecyparis thyoides* (L.) B. S. P., sown on *Amelanchier canadensis* (L.) Medic.

17. CRONARTIUM QUERCUS (Brond.) Schröt. (*Peridermium fusiforme* Arth. & Kern).—Aeciospores from *Pinus taeda* L., sown on *Quercus rubra* L., and *Q. Phellos* L.

18 and 26. COLEOSPORIUM VERNONIAE B. & C.—Aeciospores from *Pinus taeda* L. and *P. palustris* Mill., sown on *Vernonia fasciculata* Michx.; *urediniospores* from *Vernonia fasciculata* Michx., sown on same host.

B. SPECIES REPORTED NOW FOR THE FIRST TIME

1. UROMYCES ELEGANS (B. & C.) Lagerh.—Aeciospores from *Trifolium carolinianum* Michx., sown on same host, producing telia.

2. PUCCINIA NODOSA Ell. & Hark.—Aeciospores from *Brodiaea pauciflora* (Torr.) Standley, sown on same host, producing telia.

3. PUCCINIA SPLENDENS Vize.—Teliospores from *Hymenoclea monogyra* T. & G., sown on same host, producing pycnia and aecia; aeciospores sown on same host, producing uredinia and telia.

4. PUCCINIA MINUTISSIMA Arth. (*Aecidium Nesaeae* Ger.)—. Teliospores from *Carex filiformis* L., sown on *Decodon verticillatus* (L.) Ell.

5. GYMNOSPORANGIUM ELLISII (Berk.) Farl.—Teliospores on *Chamaecyparis thyoides* (L.) B.S.P., sown on *Myrica cerifera* L.

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PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—I. PEZIZA

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(With Plates 155 and 156, Containing 4 Figures)

Although the type of the genus *Peziza* is in doubt, the name stands in current usage as it doubtless should continue to do, for the large fleshy cup-fungi. Notwithstanding the number of segregates which have been made on one character or another, the genus is still represented by a fairly large number of species.

Many of the species of the genus cannot be satisfactorily studied from dried specimens alone, since the more conspicuous characters, such as color, form, etc., are entirely lost in this condition. In a number of species, the spores furnish valuable diagnostic characters, but in other cases we must rely entirely on gross character. For this reason, the species of the genus should be accompanied by complete field notes, or as is still better, by colored sketches or photographs or both.

The reproduction of the plants of this group by photographs while inferior in many ways to reproduction by color, is less expensive and shows many fine details which are lost even in the best colored illustrations. For these reasons, it is the intention to bring out from time to time illustrations of the common species of *Peziza* and other cup-fungi in such a way as to aid in determining the identity of these plants as they are collected in the field. The following illustrations represent four of the common species of *Peziza*, the photographs having been made from local specimens collected by the writer in the vicinity of New York City.

Peziza badia Pers. Obs. Myc. 2: 78. 1799

?*Peziza cochleata* L. Sp. Pl. 1181. 1753.
?*Helvella cochleata* Bolton, Fungi Halifax 3: 99 (in part). 1789.
Plicaria badia Fuckel, Symb. Myc. 327. 1869.
Aleuria badia Gill. Champ. Fr. Discom. 43. 1879.

Apothecia scattered, gregarious or more commonly cespitose, sessile, at first globose, expanding and becoming deep cup-shaped, regular in form, or infolded and cochleate or auricular, occasionally one-sided and rarely *Otidea*-like, externally varying from tan-colored when young to dark-brown with age, whitish near the base, pustulate, the pustules often reddish or purplish, becoming dark with age, reaching a diameter of 10 cm.; hymenium dark-brown; asci tapering below and often forked at the base, cylindric above; spores 1-seriate, usually oblique and often irregularly crowded, ellipsoid, with the ends quite strongly narrowed, becoming verrucose, hyaline or very faintly colored, $17–23 \times 8–10\ \mu$; paraphyses rather strongly enlarged above, yellowish.

On the ground in deciduous woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Oregon, California and Alabama; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 283;* Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 14, f. 2, pl. 15, f. 1;* Cooke, Mycographia *pl. 57, f. 226;* Gill. Champ. Fr. Discom. *pl. 42.*

EXSICCATI: Ellis & Ev. N. Am. Fungi *981.*

Peziza cochleata of Linnaeus is a species of doubtful identity. Persoon in 1801 described *Peziza badia* and cited as a synonym *Helvella cochleata* Bolton. Bolton apparently included in his description two species, one of which is commonly taken to be identical with *Peziza badia* as at present known. Bolton's *Helvella cochleata* represents his conception of *Peziza cochleata.* Some modern authors are inclined to regard *Peziza cochleata* L. as an *Otidea.* In the absence of any definite information, the writer is inclined to adhere to the early conceptions of Bolton and Persoon and regard *Peziza cochleata* L. as at least a doubtful synonym of the present species.

PEZIZA VESICULOSA Bull. Herb. Fr. *pl. 457.* 1789

?Helvella cochleata Bolton, Fungi Halifax **3**: 99 (in part). 1789.
Pustularia vesiculosa Fuckel, Symb. Myc. 329. 1869.
Aleuria vesiculosa Gill. Champ. Fr. Discom. 45. 1879.

Apothecia gregarious or more often densely cespitose, at first closed and globose, gradually expanding and becoming deep cup-shaped, regular in form or irregularly contorted, sessile or with

very stout stem-like base, externally whitish or yellowish, pustulate from the presence of minute warts, reaching a diameter of 7–8 cm.; hymenium pale-brown, darker than the exterior of the apothecium; asci cylindric or subcylindric; spores obliquely 1-seriate, ellipsoid, smooth, hyaline, 20–23 × 10–11 μ; paraphyses enlarged above, granular within, subhyaline.

On manure piles and rich soil.

TYPE LOCALITY: France.

DISTRIBUTION: New York to Washington, California and Alabama; probably throughout North America; also in Europe.

ILLUSTRATIONS: Bull. Herb. Fr. *pl. 457;* Boud. Ic. Myc. *pl. 257;* Cooke, Mycographia *pl. 63, f. 242;* Gill. Champ. Fr. Discom. *pl. 44;* Rabenh. Krypt. Fl. 1^3: 992, *f. 1–4;* Bull. Lab. Nat. Hist. State Univ. Iowa **6**: *pl. 16, f. 1;* Sowerby, Engl. Fungi *pl. 4;* Massee, Brit. Fungus Fl. **4**: 290, *f. 22.*

EXSICCATI: Ellis, N. Am. Fungi *1270.*

PEZIZA PUSTULATA (Hedw.) Pers. Syn. Fung. 646. 1801

Octospora pustulata Hedw. Musc. Frond. **2**: 19. 1787.
Plicaria pustulata Fuckel, Symb. Myc. 327. 1869.
Peziza assimilata Karst. Not. Fauna Fl. Fenn. **10**: 113. 1869.
Aleuria pustulata Gill. Champ. Fr. Discom. 45. 1879.
Peziza umbrina Boud.; Cooke, Mycographia 226 (in part). 1879.

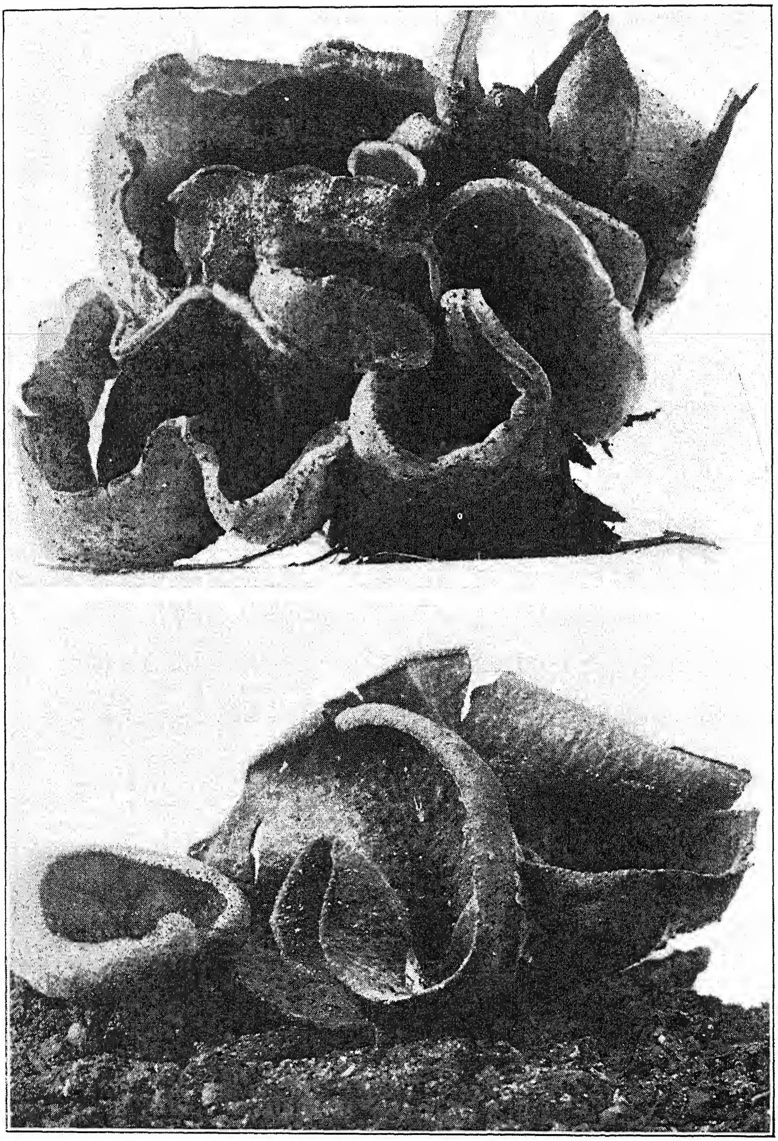
Apothecia gregarious, scattered or cespitose, at first closed and globose, gradually expanding, reaching a diameter of 3–5 cm., regular or much contorted, externally whitish and densely pustulate, the pustules giving rise to bran-like particles as the plant matures, margin usually crenate; hymenium pale- to dark-brown; asci cylindric above, reaching a length of 275 μ and a diameter of 12–14 μ; spores 1-seriate, ellipsoid, becoming minutely roughened, hyaline to faintly yellowish, 15–17 × 10 μ; paraphyses strongly enlarged and reaching a diameter of 7–8 μ.

On charcoal and burned areas.

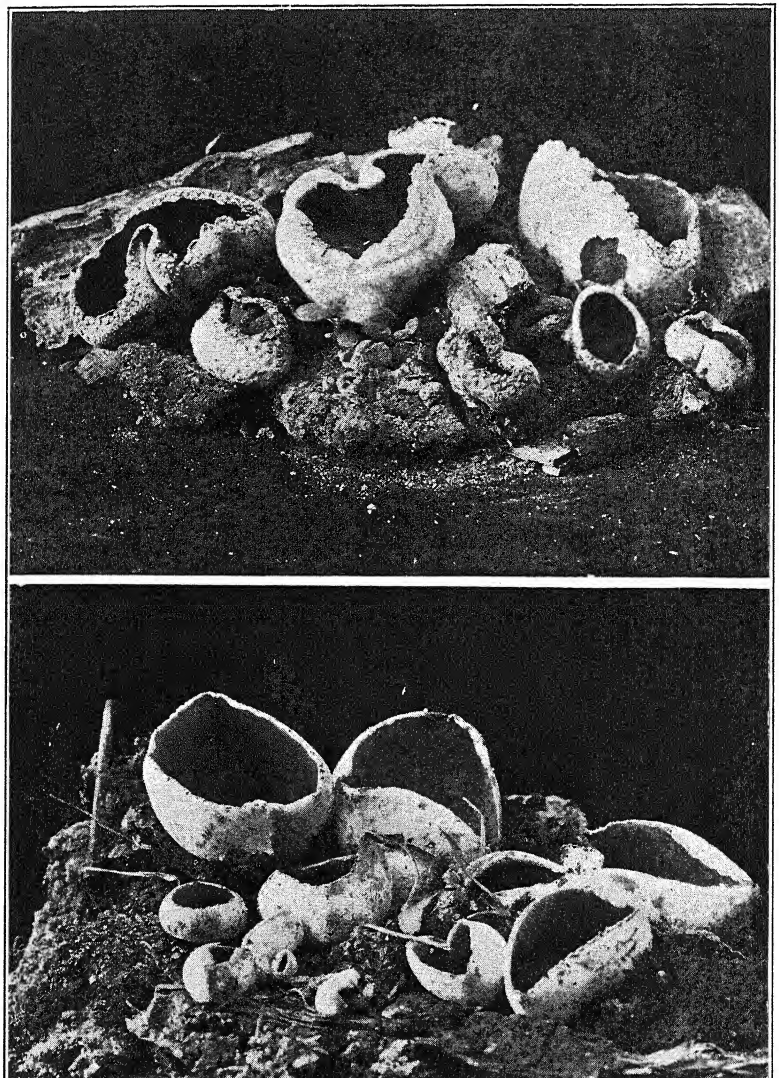
TYPE LOCALITY: Europe.

DISTRIBUTION: New York to Wisconsin; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 279;* Cooke, Mycographia *pl. 106, f. 378;* Grevillea **2**: *pl. 24, f. 2;* Hedw. Musc. Frond. **2**: pl. *6, f. 1–4;* Gill. Champ. Fr. Discom. *pl. 47, f. 2.*



PEZIZA VESICULOSA BULL.
PEZIZA BADIA PERS.



PEZIZA PUSTULATA (HEDW.) PERS.
PEZIZA SYLVESTRIS (BOUD.) SEAVER

Peziza sylvestris (Boud.)

Aleuria sylvestris Boud. Hist. Class. Discom. Eu. 45. 1907.

Apothecia gregarious, sessile, deep cup-shaped to subdiscoid, externally whitish, nearly smooth or pustulate, the margin even or slightly wavy and crenate, reaching a diameter of 3–8 cm.; hymenium umber-brown; asci cylindric above, gradually tapering below, reaching a length of 300–325 μ and a diameter of 13–15 μ; spores 1–seriate, with the ends slightly overlapping, hyaline, smooth, $17–20 \times 9–10$ μ; paraphyses strongly enlarged above, reaching a diameter of 7–8 μ at their apices.

On rubbish piles and soil in woods.

TYPE LOCALITY: Europe.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATIONS: Boud. Ic. Myc. *pl. 261.*

The species listed under this name is common about New York City. While agreeing with Boudier's description and illustrations, it is not unlikely that the species has been previously described. From our own observations, the species seems quite variable both in size and appearance, the apothecia being sometimes nearly plane and occasionally strongly warted and then resembling *Peziza bufonia* Pers. The species differs from *Peziza pustulata* in the habitat and in the spores, those of the former being strongly roughened and those of the present species permanently smooth. The size and color of the two species is almost identical.

NEW YORK BOTANICAL GARDEN.

EXPLANATION OF PLATES

PLATE CLV

Upper figure, *Peziza vesiculosa* Bull.
Lower figure, *Peziza badia* Pers.

PLATE CLVI

Upper figure, *Peziza pustulata* (Hedw.) Pers.
Lower figure, *Peziza sylvestris* (Boud.) Seaver.

THE STRUCTURE AND DEVELOPMENT OF SECOTIUM AGARICOIDES

Henry S. Conard

(With Plate 157 and 1 Text Figure)

This curious fungus was first found in Ukrain by Czerniaiev in 1845. Specimens from America described by Peck (1882) as *S. Warnei* were examined by Hollós (1903) and pronounced specifically identical with the European plants. This conclusion seems fully justified so far as can be judged by the excellent colored plate and full description given by Czerniaiev. It is therefore a plant of very wide distribution. Hollós records it from Ohio to Wisconsin and Kansas in North America, as well as from Europe, Asia, Africa (Algeria), New Zealand, and Australia (Banks Peninsula).

Secotium agaricoides resembles a puffball in general appearance, being from 4 to 6 or 8 cm. in diameter; but it stands on a short stalk, and the stalk continues through the body of the fungus as a columella. The interior is filled with branched and much folded lamellae instead of a capillitium. Sometimes the body does not dehisce at all; in other cases, it splits lengthwise or the peridium separates slightly from the stalk after the manner of an agaric. The spores are olive-brown in color when seen in mass. They are ovoid in shape and measure $7 \times 5\ \mu$. They have smooth, thick, impervious walls, with one apical germ pore. They are borne in fours on rather long sterigmata, upon clavate basidia, which at maturity are about $22 \times 6\ \mu$. The spore often carries with it a part of the sterigma as an appendage. The present study attempts to throw some light on the nature of this curious plant from the standpoint of development.

My material consisted of about 100 mature plants and 6 small young ones. One 13 mm. and one 15 mm. in diameter were collected in 1911. The others, 10 mm. tall and 8 mm. in diameter, 10 mm. tall and 9 mm. in diameter, 4 mm. tall and 3.8 mm. in

diameter, and 4 mm. tall and 3.5 mm. in diameter, were collected in 1912. All were cut open, fixed in chromo-acetic acid, sectioned in paraffin $3\frac{1}{3}$, $6\frac{2}{3}$, or 10 microns thick, and stained with various stains. The best results were obtained with Haidenhain's iron-alum-haematoxylin. The mature specimens were dry when collected and were stored in boxes.

Development.—The youngest specimens are nearly globular, white, and smooth. Then comes a "button" stage, with the upper portion slightly larger than the stalk and the surface still smooth. Later, the fertile portion increases greatly in height and diameter, leaving the free stalk as a mere basal projection. The superficial brown scales of the peridium appear only when near full maturity. The spores are fully mature while the trama, peridium, and stalk are still fleshy. The old specimens, at least in our climate, dry up and do not putrify.

The Peridium.—Sections of the 3.5 mm. specimen show an indefinite outer layer of loosely woven hyphae surrounding a dense mass of closely packed threads (Pl. 157, fig. 1). Within this globular body and near its summit a ring of deeply-staining tissue is already found. This is the fundament of the hymenophore. In older specimens, the hymenophore hyphae take a distinctly radial and longitudinal direction and form a thick and well-marked zone. Between this layer and the outer webby portion, the hyphae are less crowded and take a paler stain. Their course is predominantly longitudinal (radial). This layer is continuous below with the substance of the stalk. At this stage (9 mm. in diameter), the outer webby layer is more prominent and continues down upon the stalk of the "button." Soon after this, however, the layer completely disappears. The mature peridium shows only a broad layer of longitudinal hyphae, with a thin superficial layer of crushed and withered threads.

The outermost loose layer of the young plant (Pl. 157, fig. 5, 6) agrees in structure and position with the universal veil or blematogen of the evolvate agarics (*Agaricus,* Atkinson 1906, 1914a; *Armillaria,* Atkinson 1914b; and *Stropharia,* Zeller 1914). The second layer forms the bulk of the tissue of the peridium.

The mature peridium is fleshy to leathery in texture. It is about 2 mm. thick on the sides of the body, thinning below to nothing

when it breaks away from the stalk, and thickening above to its union with the columella. The scales on its surface are not separate from it, but when caught with forceps and peeled off, the tissue tears deeper and deeper into the peridium. The summit of the columella is continuous with the peridium and of similar structure.

In our 9 mm. specimen, there is a layer of open-meshed "neutral tissue" just within the gleba, surrounding the lower part of the columella. This layer is broadest where the peridium joins the stalk. It probably represents the layer of stem tissue which in *Agaricus campestris* is torn off with the annulus in the expansion of the cap. It appears only in this one specimen. In the 13 mm. specimen, the pileus or peridium joins the stipe by a broad confluence of tissues, representing the undifferentiated partial veil. At the line of junction, the hyphae appear greatly tangled, for the hyphae of the stipe run approximately longitudinally and are continuous with those of the columella, and the prevailing direction in the peridium is meridional. It is doubtless along this tangled region that marginal dehiscence occurs.

The Hymenophore.—The hymenophore appears in the 3 mm. specimen as a horizontal ring of deeply-staining tissue within the globular fungous body and near its summit (Pl. 157, fig. 1). The hyphae composing this ring are rich in protoplasm and very densely tangled together. They do not appear to follow any one direction more than another. Their ends are simply rounded.

In the 3.8 mm. specimen (Pl. 157, fig. 2), this dense ring of hyphae has organized a distinct palisade of round-tipped threads. A median longitudinal section of the carpophore shows this already in two deeply stained lunate areas, concave downward. The tissue beneath these patches is very loose and open, with an occasional lacuna (fig. 4). No sign of gills yet appears in tangential sections (fig. 3). Already, however, the palisade hyphae are swollen at the ends to form basidia and under these basidia the first formation of the gill chamber takes place by a tearing away of the underlying hyphae. The palisade is evidently spreading both centripetally and centrifugally. The centripetal advance encroaches on the stipe for a short time and then ceases. This causes the decurrence of the lamellae, mentioned later. The centrifugal spreading is much more rapid and continues as the "mar-

ginal growth of the pileus" until the mature size of the carpophore is reached. The boundary of the pileus is first evident in the upper part of the 3.8 mm. specimen. Thus, the hymenophore distinctly precedes the pileus and the gill chamber in differentiation.

Just how the circle of palisade gives rise to the gill system, my material does not show. My next stage (9 mm., fig. 5, 6) has a ring of well-formed gills extending from the cap toward the columella. The gills are much branched and anastomosing. They run primarily in a radial direction. Near the apex of the body, the gills are united with the columella, or in other words are decurrent (fig. 6, *a*). An older specimen shows the tramal tissue apparently continuous with the columella in many places. This is doubtless the result of a secondary mingling of hyphae, for in mature specimens the gleba is everywhere adherent to the columella, while in the 10 mm. specimen there is a distinct air cavity between the gills and the columella. Growth of the gills is chiefly marginal, though apparently folds may originate and develop at any place. The extension of the gill system as a whole takes place in the region where the peridium joins the stem; corresponding to the marginal or centrifugal extension of agarics (fig. 6, *b*). In this region, the hyphae are narrow, protoplasmic, densely crowded, nearly parallel, and curved downward and inward. They have simple rounded ends. As general growth of the fertile portion of the carpophore goes on, a loosening of the tissues between this growing zone and the stem occurs and into this loose region the hymenophore hyphae constantly penetrate. Quickly the hyphae branch and form a dense hymenium of long, clavate basidia.

The mature gills are much branched and folded. The tramal tissue consists wholly of long, branching, and nearly parallel hyphae, whose ultimate branchlets form the densely crowded basidia. There are no cystidia or other aberrant cells. From a fairly dense web in growing stages, the trama becomes looser toward maturity and finally becomes dry and fragile. From the above account, it is clear that the carpophore of *Secotium agaricoides* presents in its origin and development an exact counterpart of that of *Agaricus* (Atkinson 1906, 1914a). There is at

first a universal veil like that of several evolvate agarics (*Agaricus*, *Armillaria*, and *Stropharia*). There is an ill-differentiated partial veil. The origin of the hymenophore agrees precisely with that of all recently reported agarics, except *Hypholoma* (Allen 1906) and *Coprinus* (Levine 1914). The marginal growth of the gill system is also familiar in the mushrooms. The columella comes into being exactly as does the stipe of mushrooms. Indeed, we might well speak of stipe and pileus of *Secotium*, rather than of peridium and columella. The basidia and spores have the shape, size, and arrangement found in agarics. The copious branching of the gills exceeds anything seen in agarics. The failure of the cap and gills to expand, the drying up of the trama into a friable mass of tissues and spores, the olive-brown color of the spores, and the freedom of the spores to "puff" when the exposed mass is touched, are all lycoperdinean characters.

Histology and Cytology.—The cell structures of *Secotium* present nothing novel. In the sections showing the earliest fundament of the hymenophore, there are in the ring of active growth a few hyphae which are twice as stout as the others; they stain of an even dark color with haematoxylin, without granules of any kind. In the 9 mm. specimen, many hyphae in the stipe, columella, pileus, and trama stain deep-red with safranin. They are of the usual diameter and show no granules. As the stem of this specimen is bored by insect larvae (fig. 6), these may be dead hyphae. They are absent from the region of active growth at the margin of the pileus.

The cells of the mycelium vary from 2 to 10 times as long as wide. The end walls usually show the little central mass of stainable material associated by Strasburger with the pores in the partition (fig. 1, 5). In several instances, the cells of the tramal hyphae had two distinct nuclei. Metachromatic bodies are numerous, especially in the hymenium and regions of active growth. Many paler bodies were seen along the walls of some cells.

The rhizomorph connected with the base of the carpophore in my 3.8 mm. specimen is composed of three kinds of hyphae. (1) Most hyphae are very slender (3.5 microns), homogeneous or slightly granular. They form the fundamental tissue of the entire structure (fig. 1, 11). (2) Among these are groups or

strands of larger hyphae (fig. 1, 11), and occasionally very large ones (10 microns). These show distinct nuclei, certain globular bodies, and numerous square crystals (fig. 1, 13). As the crystals stain deeply, they are probably of protein, as found by van Bambeke in *Lepiota meleagris*. The course of these larger hyphae is mostly longitudinal, but they are much tangled. They are not found in the carpophore. (3) On the surface of the rhizomorph, are many slender (2.5 to 3 microns) hyphae with very thick walls (1 micron, fig. 1, 12); in places they form a rather compact layer, but they occasionally extend into the center of the rhizomorph. The walls stain both with haematoxylin and eosin; no contents were observed.

The young basidium possesses two nuclei near the middle of the cell (fig. 1, 12), usually lying in the longitudinal axis of the cell. These nuclei, like those of the mycelium generally, are small, sharply outlined, with one large nucleolus and little or no other visible substance. Later a single large nucleus of similar structure is found near the distal end of the basidium (fig. 1, 6, 8). Although satisfactory fusion stages were not found (fig. 1, 3, 4), there is doubtless a fusion of nuclei to form this one large nucleus. Still later, two (fig. 1, 7) and then four nuclei are found, clustered about the apex of the basidium (fig. 1, 8). The mitoses were not observed. The four sterigmata then grow out symmetrically and a spore forms on each (fig. 1, 9, 10). The entrance of the nuclei into the spores was not observed, but some of the spores were clearly seen to possess a single nucleus.

So far as observed, then, the cytology of *Secotium* agrees with that of other hymenomycetes.

Discussion.—What of the relationships in general? Fischer (1899) in the Pflanzenfamilien admits "about twenty species" of *Secotium,* including the genera *Endoptychum* Czern. and *Elasmomyces* Cav. The gill structures of *S. erythrocephalum* Tul. and *S. Mattirolianus* (Cav.) agree well with those of *S. agaricoides* (Czern.), but Cavara (1897) describes a large-celled pseudoparenchyma in the stipe and peridium of his species. This tissue occurs in layers alternating with layers of hyphal tissue. The spores, also, of *S. Mattirolianus* are rough, roundish, and of two sizes. Cystidia occur in Cavara's species, as also according to

Corda (1854) in *S. Gueinzii* Kunze. No cysts are described by Corda for *S. melanosporum* Berk. or *S. coarotatum* Berk. If, therefore, Fischer has done well in uniting *Endoptychum* and *Elasmomyces* with *Secotium,* we must recognize two or perhaps three well marked subgenera. The other species of *Secotium* are not well enough known to admit of discussion.

Regarding the other genera united with *Secotium* by Fischer (1899) in his Secotiaceae, *Polyplocium,* as Fischer himself notes, is nearer to *Boletinus* than it is to *Secotium. Gyrophragmium* may prove to be near to *Secotium,* but Fischer regards it as close to *Montagnites* and *Coprinus,* to which *Secotium* is certainly not closely allied. As to *MacOwenites* and *Cauloglossum,* too little is known of them, but they do not seem to resemble *Secotium* so closely as the latter resembles *Agaricus.*

The Hysterangiaceae and Hymenogastraceae which make up the rest of the Hymenogastrineae of Fischer are each fairly homogeneous in themselves. They relate quite distinctly to the Clathraceae, Lycoperdacaeae, and Nidulariaceae. They resemble Secotiaceae only in the fact that their spores mature while the hymenophore is still fleshy. But this is equally true of Agaricaceae. There remains therefore no real unity in Fischer's Hymenogastrineae and that author's opinion seems strengthened that the Secotiaceae, at least should be dismembered and its genera distributed among the Hymenomycetes.

Fischer (1900) and Lotsy (1907) have considered *Secotium* as a possible point of departure for the Phallaceae. Lotsy refers directly to the little known *S. olbium.* The argument is based on the manner of development of the hymenophore. Further, Corda's figure of *S. Gueinzii* (Pl. 6, fig. 12) shows trabeculae running through the gleba from the top of the stipe to the peridium, after the manner of a young clathroid, but Corda's section cannot be median, as it shows no columella; and it throws no light on the origin of the hymenophore. We have seen that in respect to development *S. agaricoides* is precisely like *Agaricus campestris* and *A. arvensis* as described by Atkinson (1906, 1914a). It is not like *Phallus* or *Mutinus,* nor can the stipe and columella of *Secotium* be likened to the stalk of a phalloid; for the phalloid stem probably represents a sterilized gleba, and is therefore

comparable with the sterile base of a *Lycoperdon*. But the columella of *Secotium agaricoides* is in its origin, development, and structure strictly agaricinean. There would seem to be no support whatever for relating our plant to the Phallaceae. The likeness of *Secotium* to a puffball as noted on a previous page, though quite real, is decidedly superficial, and cannot carry much weight.

On the whole, *S. agaricoides* would best be placed near to *Agaricus* (*Psalliota*), either in the Agariceae or Marasmiae of Hennings (1897). It clearly falls within the Agaricaceae of Maire (1902). It is to be regarded as a primitive or arrested agaric,—perhaps a paedogenic form, reaching its reproductive maturity in the "button" stage.

SUMMARY

1. *Secotium agaricoides* is a widespread species, occurring in Europe, Asia, Africa, North America, Australia, and New Zealand.

2. In the young carpophore, the fundament of the hymenophore first appears, followed by the demarcation of the margin of the pileus and the appearance of a gill cavity.

3. The development of the "peridium" is like that of the cap of *Agaricus campestris*, showing a primitive *velum universale* and a pileus. No true *velum partiale* is found, though a layer of "neutral tissue" occurs which may represent it. The universal veil disappears during the maturation of the plant.

4. The hymenophore consists of radiating, branched, and anastomosing gills decurrent at the top of the columella.

5. The trama and hymenium are simple in structure, without pseudoparenchyma or cystidia.

6. The young basidium has two nuclei, which unite to form one. This latter divides twice to form four nuclei for the four spores. The mycelial cells are binucleate.

7. *Secotium agaricoides* is nearly related to *Agaricus* (*Psalliota*), being an arrested or paedogenic form. It is not closely related to the Gasteromycetes or Phalloids.

The author is indebted to the Botanical Department of the State

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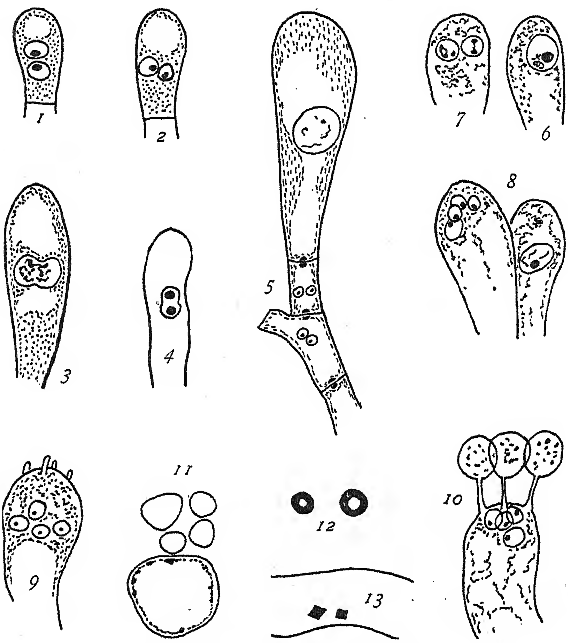


FIG. 1. 1, 2, young binucleate basidia. 3, 4, fusion of nuclei in young basidium. 5, uninucleate basidium, with cells of subhymenium. 6, fusion-nucleus of basidium, probably in synapsis. 7, two nuclei resulting from division of fusion-nucleus. 8, basidium on right with fusion-nucleus; on left 4-nucleate stage. 9, budding out of sterigmata. 10, formation of basidiospores. 11, central hyphae of rhizomorph in cross section; two sizes with intercellular spaces. 12, thick walled hyphae from surface of rhizomorph. 13, protein crystals in large hyphae of rhizomorph. All drawings made with camera lucida; 1, 2, 3, 4, 5, 11, 12, 13 with $\frac{1}{6}$ in. objective; 6, 7, 8, 9, 10, with $\frac{1}{12}$ in. objective.

DESCRIPTION OF PLATE CLVII

Photomicrographs by Paul H. Smith

Fig. 1. Median longitudinal section of specimen 3.5 mm. in diameter. First indications of pileus and hymenophore.

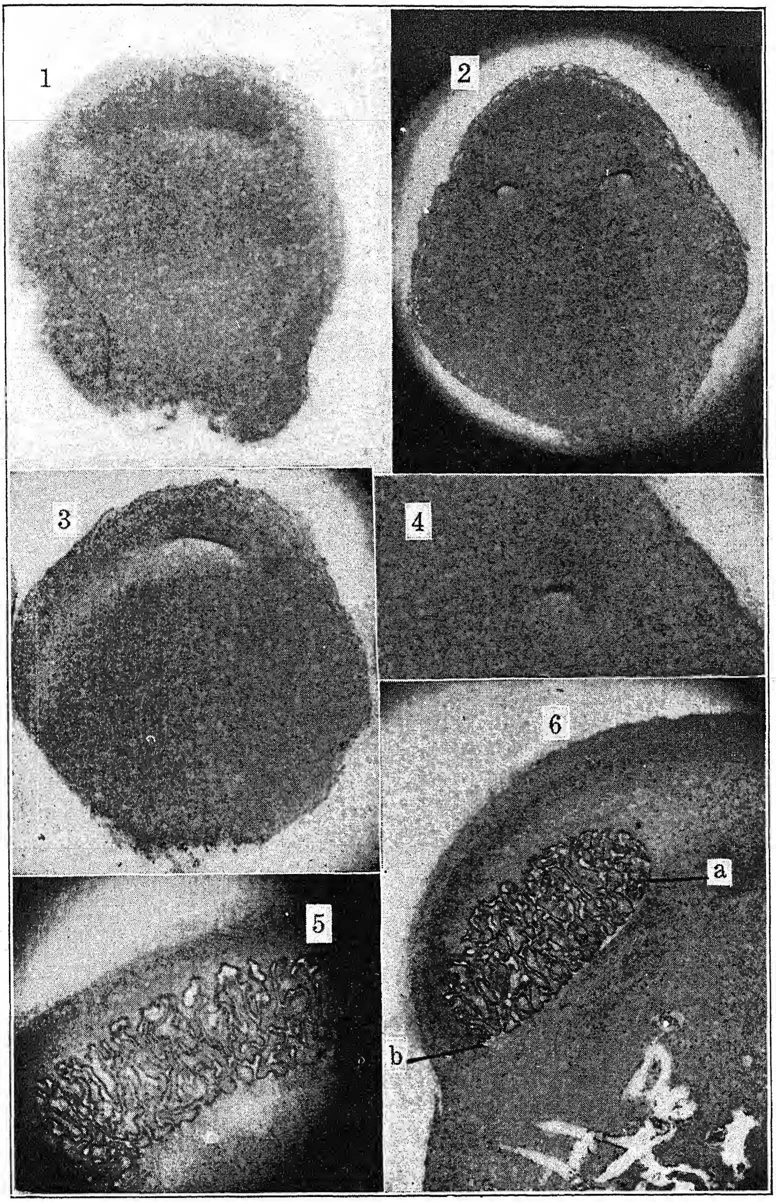
Fig. 2. Median longitudinal section of 3.8 mm. specimen. Fundament of hymenophore and gill chamber.

Fig. 3. Tangential section of same specimen.

Fig. 4. Portion of Fig. 2, enlarged.

Fig. 5. Transverse section of 9 mm. specimen.

Fig. 6. Median longitudinal section of 9 mm. specimen. a, decurrence of gills; b, marginal growth of gills.



SECOTIUM AGARICOIDES (CZERN.) HOLLÓS

THE GENUS LEPISTA

William A. Murrill

This genus, which is closely related to *Entoloma,* was founded by W. G. Smith in 1870, with *Paxillus Lepista* Fries as its type. Gillet included in it only those species having very decurrent lamellae, which were related rather to *Paxillus* than *Tricholoma.* Maire, in 1913, erected the genus *Rhodopaxillus,* to include *Tricholoma panaeolum, T. nudum, T. personatum,* and a few other related species.

Lepista (Fries) W. G. Sm. Clavis Agar. 26. 1870

Hymenophore large, fleshy, putrescent; surface smooth, not viscid, margin at first involute; lamellae adnexed or slightly decurrent; spores rosy-ochraceous in mass, not angular; stipe central, fleshy; veil none.

Type species, *Paxillus Lepista* Fries.

Spores 7–10 × 4–5 μ.	
Stipe 15–30 mm. thick.	1. *L. personata.*
Stipe 4–8 mm. thick.	2. *L. domestica.*
Spores 5–6 × 3–4 μ; species very rare.	3. *L. panaeola.*

1. Lepista personata (Fries) W. G. Sm. Clavis Agar. 37. 1870

?*Agaricus nudus* Bull. Herb. Fr. *pl. 439.* 1789.

Agaricus violaceus Sow. Engl. Fung. *pl. 209.* 1799. Not *Agaricus violaceus* Schaeff. 1774.

Agaricus bicolor Pers. Syn. Fung. 281. 1801. Not *Agaricus bicolor* Batsch. 1783.

Agaricus personatus Fries, Obs. Myc. **2**: 89. 1818.

Tricholoma personatum Quél. Champ. Jura Vosg. 45. 1872.

Rhodopaxillus personatus Maire, Ann. Myc. **11**: 338. 1913.

Pileus compact, becoming soft, thick, convex or plane, obtuse, regular, solitary or gregarious, 5–12 cm. broad; surface moist, glabrous, variable in color, generally pallid or cinereous tinged with violet or lilac, sometimes wholly violet, margin at first involute and villose-pruinose, becoming glabrous; context whitish, pleasant to the taste, edible; lamellae broad, crowded, rounded behind,

free, violaceous, becoming sordid-whitish or fuscous; spores ellipsoid, smooth, sordid-white, dull-pinkish in mass, 7.5–10 × 4–5 μ; stipe generally thick, often bulbous, solid, fibrillose or villose-pruinose, whitish or concolorous, 3–7 cm. long, 1.5–3 cm. thick.

TYPE LOCALITY: Europe.

HABITAT: In open woods or among long grass in fields.

DISTRIBUTION: Temperate North America; also in Europe.

ILLUSTRATIONS: Ann. Rep. N. Y. State Mus. **48**: *pl. 22;* Hussey, Ill. Brit. Myc. **2**: *pl. 40;* N. Marshall, Mushr. Book *pl. 16;* Mycologia **2**: *pl. 19, f. 1;* Sow. Engl. Fungi *pl. 209.*

EXSICCATI: Sydow, Myc. Mar. *3403, 2305*; Thüm. Fungi Austr. *1004;* Herpell, Präp. Hutpilze *63.*

2. **Lepista domestica** Murrill, nom. nov.

Agaricus sordidus Fries, Syst. Myc. **1**: 51. 1821. Not *Agaricus sordidus* Dicks. 1785.

Tricholoma sordidum Quél. Champ. Jura Vosg. 47. 1872.

Rhodopaxillus sordidus Maire, Ann. Myc. **11**: 338. 1913.

Melanoleuca sordida Murrill, Mycologia **6**: 3. 1914.

Pileus thin, convex to plane or slightly depressed, subumbonate at times, often irregular, gregarious or cespitose, 3–7 cm. broad: surface smooth, glabrous, pale-violet to avellaneous with ochraceous hues, usually fuliginous on the disk, margin naked, involute when young; context violaceous to whitish, mild, edible; lamellae sinuate to slightly decurrent, narrow, crowded, concolorous when young, fading with age; spores ellipsoid, smooth, pale-rosy-ochraceous in mass, 7–8 × 4–5 μ; stipe eccentric at times, equal, firm, concolorous, glabrous, stuffed or hollow, 3–8 cm. long, 4–8 mm. thick.

TYPE LOCALITY: Europe.

HABITAT: About manure piles and in manured ground.

DISTRIBUTION: Temperate North America; also in Europe.

ILLUSTRATIONS: Bull. N. Y. State Mus. 116: *pl. 104;* Bull. N. Y. State Mus. 131: *pl. 115;* Cooke, Brit. Fungi *pl. 100* (*125*); Fries, Ic. Hymen. *pl. 45;* Mycologia **6**: *pl. 113, f. 4.*

3. LEPISTA PANAEOLA (Fries) P. Karst. Bidr. Finl. Nat. Folk 481. 1879.

Agaricus panaeolus Fries, Epicr. Myc. 49. 1838.

Agaricus ectypus Secr. Mycogr. Suisse **2**: 86. 1833. Not *Agaricus ectypus* Fries, 1821.

Tricholoma panaeolum Quél. Champ. Jura Vosg. 45. 1872.
Gyrophila nimbata Quél. Fl. Myc. Fr. 271. 1888.
Rhodopaxillus panaeolus Maire, Ann. Myc. **11**: 338. 1913.

Pileus fleshy, convex to expanded, gibbous, sometimes eccentric, cespitose, 4–9 cm. broad; surface whitish-gray, grayish-variegated and dull-flesh-colored when young; context gray, odor strong, farinaceous-rancid, taste mild; lamellae mostly crowded, sometimes narrow and sometimes broad, easily separable from the hymenophore, sinuate-uncinate, sometimes decurrent, from whitish-gray to lurid-flesh-colored or rufescent; spores ellipsoid, slightly tuberculose, hyaline, dull-rosy in mass, $5.5–6 \times 3.5\,\mu$; stipe solid, gray to grayish-fuscous within, subequal, fibrillose, subfurfuraceous at the apex, 2–6 cm. long, 5–13 mm. thick.

TYPE LOCALITY: Switzerland.

HABITAT: In grassy places in the open or near woods; rarely in woods.

DISTRIBUTION: New York; also in Europe.

ILLUSTRATION: Fries, Ic. Hymen. *pl. 36, f. 2.*

NEW YORK BOTANICAL GARDEN.

MARKING TYPES IN THE MYCOLOGICAL HERBARIUM

William A. Murrill

An article by Swingle on the designation of types appeared in *Science,* June 6, 1913, in which the discussion was confined to flowering plants. Dr. Swingle's statement that a type has no duplicate would hardly be appropriate when applied to fungi, since several sporophores usually arise from the same mycelium and the type collection may include one or more of these sporophores. For this reason, I would suggest the term extype instead of clastotype for a part of the type, since a part of the type is not necessarily a fragment. The term cotype should be omitted altogether, to avoid confusion. The principal terms to be used would then be: *type collection, type* (including *lectotype*), *extype* (including *clastotype*), *microtype* (suggested for a part of the type mounted for microscopic study), and *paratype* (including *syntype*).

Rubber stamps bearing the words "Type Coll.," "Type," "Extype," "Microtype," and "Paratype" may be used in the mycological herbarium with great advantage.

It frequently happens that a collector is unable to distinguish closely related plants and places two or more species under one field number. In such cases, the actual specimens used by the publisher of the species would be the type and it would be unsafe to designate as such any other portion of this same collection.

Certain questions will always arise which will be settled differently by different persons. For example, if a portion of a collection is sent away to a specialist and he makes it the type of a new species, the remaining portion may not always receive the same designation. In the case of mosses, it is quite necessary that the one who publishes the species should see all the material in order to be sure that it is the same thing. This may be true in various other groups also.

New York Botanical Garden.

NEWS AND NOTES

Professor J. C. Arthur and Dr. F. D. Fromme, of Purdue University, Lafayette, Indiana, spent the month of January at the Garden in continuation of their studies of the Uredineae for *North American Flora.*

Mr. C. A. Schwarze spent most of January and February at the Garden examining and making illustrations from herbarium material relating to the parasitic fungi of New Jersey.

According to J. H. Faull and G. H. Graham, the chestnut canker has been found at Agassiz, British Columbia, on trees of Oriental, European, and American origin.

Dr. Charles E. Bessey, Professor of Botany at the University of Nebraska for over thirty years, died at Lincoln on February 25. He was born at Milton, Ohio, May 21, 1845.

Dr. A. G. Johnson, of the University of Wisconsin, recently visited the Garden to examine the collections of *Helminthosporium* in the mycological herbarium.

The chestnut canker was collected twice in Nebraska during last September and October by R. G. Pierce. The chestnut is not native in Nebraska, but it is beginning to be planted in some parts of the state and the disease was introduced with Paragon nursery stock from Pennsylvania.

Miss Caroline Rumbold, in *Phytopathology* for February, gives a brief account of successful experiments in infecting chestnut

burrs and nuts with the chestnut canker. Nuts infected with the canker become soft and crumbly and are extremely bitter to the taste. There is no doubt that the disease may very easily be spread by means of these infected fruits.

Dr. George G. Hedgcock, of the Bureau of Plant Industry, spent the first two weeks in February at the Garden examining specimens of various tree-destroying fungi. He brought a very large and valuable collection with him for comparison and was able to spare portions of many of the specimens for the Garden herbarium.

"Southern Polypores," by W. A. Murrill, appeared January 30, 1915. New combinations used in this work are: *Inonotus ludovicianus* (Pat.) Murrill, *Elfvingiella fasciata* (Sw.) Murrill, and *Spongipellis fragilis* (Fries) Murrill. "American Boletes" and "Northern Polypores," by the same author, were issued December 8, 1914. In the latter work, two new genera, *Fulvifomes* and *Elfvingiella,* were published, with several new combinations.

In the *Annals of the Missouri Botanical Garden* for September and November, 1914, Professor E. A. Burt continues his treatment of the Thelephoraceae of North America, devoting one paper to *Craterellus* and one to *Craterellus borealis* and *Cyphella.* His key to *Craterellus* includes 17 species, 5 of which are described as new and 1 newly combined. Twenty-one species are included under the genus *Cyphella,* 5 of which are new. Both papers are well illustrated.

A bulletin on practical tree surgery, by J. F. Collins, recently published by the Division of Forest Pathology at Washington, contains very careful directions for treating the trunks of trees that have suffered from wounds or diseases. The author states that the science of tree surgery has suffered from dishonest and uneducated men engaged in this work, and he predicts that very

superior methods will be discovered and put into practice in the near future. The most valuable paragraph in the bulletin reads as follows: "Finally, tree owners are urged to remember at all times the axiom: The need of tree surgery 15 or 20 years hence may be very largely obviated by promptly attending to the fresh injuries of to-day."

Some observations on abortive sporophores of wood-destroying fungi were reported by James R. Weir in *Phytopathology* for February, 1915. He comes to the conclusion that the peculiar abnormal growths on birch trunks are without doubt sterile sporophores of *Pyropolyporus igniarius*. He has found similar abortive sporophores of this species on alder trunks in Montana, and sterile ram's-horn-like sporophores of *Porodaedalea Pini* on the western white pine. An interesting statement made by Mr. Weir in this article is to the effect that the mycelium of one species attacking a tree trunk is always antagonistic to that of another species on the same trunk, and, since the mycelium of typical *Pyropolyporus igniarius* is not antagonistic to that of its principal variety, *P. igniarius nigricans,* the latter cannot be looked upon as a distinct species.

Charles Horton Peck Retires

The following minute has been adopted by the regents of the University of the State of New York on the retirement of Dr. Charles H. Peck from the position of state botanist:

The service rendered to the state by Charles Horton Peck, D.Sc., who has just retired from his position as state botanist, has been extraordinary in its fidelity, assiduity and productiveness. Dr. Peck entered the staff of the State Museum as botanist in 1867, and from that date to the present, his service has been continuous—a period of 48 years. In 1883 the position of state botanist was created and he has been its only incumbent.

The nearly half century of his scientific activity became an epoch in the science of botany in America, by virtue of the extensive contributions which he made, not alone to the knowledge of the flora of New York but specially through his almost pioneer investigations among the fungi. His researches in this field vastly increased the sum of knowledge and established an orderly and rational classification so that his published papers, issued in the reports of the state museum, are indispensable to any student of these forms of life.

The number of species discovered and described by him are counted by thousands and the additions made through his efforts to the state herbarium are so extensive that this collection of plants is to-day among the largest on the continent and of great scientific worth. By common consent of his colleagues Dr. Peck has long been recognized as the ultimate authority in mycology—the field of his special labors.

In view of these services whose value to the state can not be briefly estimated or readily expressed, the regents take this occasion to record, with their regret that the exactions of time have impelled him to retire from the service of the university and the state, their congratulations to Dr. Peck upon a life well rounded and a work well done, with their assurance of continued interest and deep regard for his welfare during the years that may remain.

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ILLUSTRATIONS OF FUNGI

MYCOLOGIA

Vol. VII May, 1915 No. 3

ILLUSTRATIONS OF FUNGI—XX

William A. Murrill

Most of the illustrations on the accompanying plate were drawn from specimens collected in or near the New York Botanical Garden. Two of them, figures 3 and 5, were copied from studies by Mr. George E. Morris. *Clitocybe illudens* is distinctly poisonous, but easily recognized; *Collybia platyphylla* is edible, but of little importance as food.

Clitocybe illudens (Schw.) Sacc.

Deceiving Clitocybe. Jack-my-lantern

Plate 158. Figure 1. × 1

Pileus convex to plane or depressed, irregular, often umbonate, densely cespitose, 10–20 cm. broad; surface glabrous, saffron-yellow; context thick, white or yellowish becoming sordid with age, the odor agreeable and the taste not characteristic; lamellae broad, decurrent, saffron-yellow; spores abundant, globose, hyaline, 4–5 μ; stipe long, firm, glabrous, concolorous, tapering toward the base of the cluster.

This species is readily recognized by its large size and brilliant coloring. It occurs throughout the eastern United States from midsummer to autumn in large clusters about dying trunks and stumps of deciduous trees. On dark nights, these clusters and also pieces of dead wood containing the mycelium are usually conspicuously phosphorescent. The plant is distinctly poisonous,

[Mycologia for March, 1915 (7: 57–114), was issued April 9, 1915.]

showing a muscarin reaction on the nerves of the heart, and producing nausea, vomiting, and diarrhea. An article on the poisonous properties of this interesting species appeared in *Mycologia* for July, 1913.

Hypholoma lacrymabundum (Bull.) Quél.

WEEPING HYPHOLOMA

Plate 158. Figure 2. × 1

Pileus rather fleshy, ovoid to expanded, sometimes broadly umbonate, solitary or cespitose, 5–8 cm. broad; surface fulvous to isabelline with intermediate shades, darker on the umbo, covered when young with appressed, matted fibers, which may disappear with age or collect into small squamules, the cuticle cracking areolately at times, margin not striate; context very thin, concolorous, the taste mild or slightly disagreeable, the odor not characteristic; lamellae rather crowded, sinuate-adnexed or adnate, somewhat ventricose, yellowish, shading to umber and spotted with black and rusty-brown as the spores mature, whitish on the edges; spores nearly lemon-shaped, apiculate, opaque, tuberculose, very dark brown under the microscope, black in mass, $8–10 \times 4–6\,\mu$; cysidia abundant, $40 \times 9\,\mu$; stipe equal or slightly enlarged below, subconcolorous, nearly white at the apex, hollow, 5–10 cm. long, 8–12 mm. thick; veil of whitish, fibrous tufts adhering partly to the margin and partly to the stipe.

This species is not uncommon in many parts of the eastern United States and Europe, in grass or weeds in the open or among leaves or about old stumps in thin woods, appearing from the middle of June to October in this latitude. It comes up regularly on my lawn each year, sometimes solitary and sometimes in dense clusters, but always attractive because of its splendid coloring and its peculiar "weeping" character. Its surface characters vary considerably with age and weather conditions. I have not tested its edibility.

The history of this species is rather confusing. It was originally described by Bulliard as *Agaricus lacrymabundus* and figured by him and by Sowerby. Persoon gave it a new name, *Agaricus velutinus,* which Fries reduced to a variety when he took up Bulliard's name, but later, in figuring the species, Fries emphasized

the squamulose character often seen in large, old plants rather than the more usual appressed-fibrillose character of the surface. While the two specific names above cited refer to the same thing historically, they have been used in this country to distinguish the squamulose specimens of this group from the fibrillose or velvety ones. There is no doubt that we have in America some varieties or species not represented in Europe, all with the peculiar, opaque, tuberculose, lemon-shaped spores. Peck's key to these is given here for the convenience of collectors. The different generic names that have been assigned to this group need not be discussed at present.

PECK'S KEY TO HYPHOLOMA § VELUTINA

Pileus persistently hairy-sqamulose or fibrillose.	
Hymenophore cespitose; spores 8–10 × 5–6 μ.	1. *H. lacrymabundum.*
Hymenophore gregarious; spores 10–12 × 6–8 μ.	2. *H. rigidipes.*
Pileus partly or wholly glabrous.	
Pileus smooth, the cuticle often rimose.	3. *H. Boughtoni.*
Pileus rugose or radiately wrinkled.	
Pileus tawny; spores rough.	4. *H. rugocephalum.*
Pileus brown; spores smooth.	5. *H. delineatum.*

Mycena pura (Pers.) Quél.

PURE MYCENA

Plate 158. Figure 3. × 1

Pileus fleshy, thin, campanulate or convex to expanded, obtusely umbonate when young, 2–5 cm. broad; surface smooth, glabrous, of uniform color, varying from rose to rose-purple, violet, or lilac, margin striate, upturned with age; lamellae rather broad, adnate to sinuate, sometimes wavy and crenate on the edges, venose-connected, varying from white to shades of rose or violet, sometimes white on the edges; spores oblong, hyaline, 6–8 × 3–3.5 μ; stipe firm, smooth subglabrous, concolorous, hollow, somewhat villose at the base, 5–8 cm. long, 2–4 mm. thick.

This beautiful little species is common on the ground in woods throughout temperate North America and Europe. It varies considerably in shape, sometimes being small and bell-shaped with a long stipe and at other times being quite broad and from convex to plane with a short stipe. An old French chart includes

it among the dangerous species, but its properties have probably not been thoroughly investigated. Even if harmless, it is too small and thin to be considered for food. The color varieties of this species had already received several specific names before Persoon grouped them under *Agaricus purus*.

Collybia platyphylla (Fries) Quél.

BROAD-GILLED COLLYBIA

Plate 158. Figure 4. × 1

Pileus large, thin, fragile, convex to expanded, 8–15 cm. broad; surface whitish to grayish-brown or dark-brown, at times darker on the disk, innately fibrillose to subglabrous, margin often upturned with age; context white, sometimes with a faint agreeable odor; lamellae adnexed, very broad, usually deeply emarginate, subdistant, white; spores subglobose or broadly ellipsoid, smooth, hyaline, 7–10 × 6–7 μ; stipe equal or tapering upward, often striate, whitish, sometimes slightly pulverulent at the apex, fleshy, stuffed or hollow, 7.5–12 cm. long, 2 cm. thick.

This large, conspicuous species is abundant throughout most of temperate North America and Europe, occurring in thin woods on and about deciduous logs and stumps, from June to October. The collector is apt to assign it to the genus *Melanoleuca,* because of its sinuate lamellae and rather fleshy stipe, but it may be distinguished from most of the species of this genus by its wood-loving habit. Although edible, it is quickly attacked by insects and also decays rapidly, so that it is practically of very little economic importance.

Lepiota amianthina (Scop.) Quél.

GRANULOSE LEPIOTA

Plate 158. Figure 5. × 1

Pileus ovoid to campanulate and expanded, subumbonate, 2–6 cm. broad; surface finely to coarsely granulose, ochraceous to reddish-ferruginous varying to pallid or pinkish; context thin, white or yellowish, often with a disagreeable odor; lamellae free

to adnexed or adnate, rather broad, close, white becoming yellowish; spores ellipsoid or subglobose, smooth, hyaline, 3–7 × 2.5–4 μ; stipe subequal, slender, fistulose, scaly below the annulus and concolorous, 4–8 cm. long, 2–7 mm. thick; veil lacerate, more or less appendiculate.

This species is common in a great variety of forms throughout temperate North America and Europe, occurring in woods on the ground or at times on decayed logs. The surface of the pileus is characteristically granulose, although its variations in color are very confusing, and the lamellae may be free, adnexed, or adnate. A monograph of the 88 North American species of the genus *Lepiota* appeared in Volume 10, part 1, of *North American Flora,* issued in July, 1914.

Lentodium squamosum (Schaeff.) Murrill

SCALY LENTODIUM

Plate 158. Figure 6. × 1

Pileus fleshy to tough, compact, hard when dry, convex or nearly plane, sometimes slightly depressed in the center and sometimes umbonate, solitary or cespitose, 5–15 cm. broad; surface white or pale-ochraceous, the cuticle cracking and usually forming brownish, spot-like scales, which are sometimes almost black; context white, with agreeable odor; lamellae subdistant, broad, sinuate-decurrent, transversely lacerate and dentate-serrate on the edges, white; spores ellipsoid, 7–15 × 3–6 μ; stipe white or whitish, short, hard, solid, often pointed at the base, more or less adorned with recurved scales, sometimes eccentric, 2.5–6 cm. long, 6–12 mm. thick; annulus fixed, white, often disappearing.

This conspicuous species, usually known as *Lentinus lepideus,* occurs abundantly throughout temperate and tropical North America, as well as in Europe and Asia, on structural timbers and logs, especially of coniferous trees. It is very important as a timber-destroying fungus, railway ties being particularly subject to its attack. Although not poisonous, it is too tough to be used for food. Its large size and scaly surface should enable the student to distinguish it very readily.

Hypholoma Candolleanum (Fries) Quél.

VIOLET-GILLED HYPHOLOMA

Plate 158. Figure 7. × 1

Pileus thin and fragile, convex to expanded; gregarious or cespitose, 3–6 cm. broad; surface smooth or rugose, striate at times, glabrous or slightly floccose, hygrophanous, dark-fulvous, fading to isabelline on dry days; lamellae adnexed, crowded, narrow, pallid to purplish when young, purplish-black with age; spores oblong-ellipsoid, very blunt at each end, smooth, dark-brown in mass, pale-purplish-brown under the microscope, copious, 6–7 × 3–4 μ; stipe slender, equal, hollow, white, smooth, glabrous or slightly flocculose, striate at the apex, 3–7 cm. long, 4–6 mm. thick; veil white, very slight and delicate, clinging partly to the margin and partly to the stipe, soon vanishing.

This edible species is not uncommon on the ground or on rotten wood in deciduous woods in temperate regions, although it is not well known in this country. DeCandolle originally assigned to it the name *Agaricus violaceolamellatus,* on account of the violet color of the young lamellae, by which it may be distinguished from its very near relative, *Hypholoma appendiculatum,* described and figured in *Mycologia* for January, 1912. Fries, in 1818, changed the name to *Agaricus Candolleanus,* probably disliking the specific name chosen by DeCandolle because of its length. The specimens I have seen do not show the violet color in the very young lamellae and are not so large as the European plant, but, in a difficult group like this one, I suppose some allowances must be made.

NEW YORK BOTANICAL GARDEN.

NOTES ON CRYPTOPORUS VOLVATUS

Sanford M. Zeller

(With Plate 159 and 1 Text Figure)

Crytoporus volvatus is unique among polypores, for the pore-bearing layer is hidden by a volva. It is thus often termed the "hidden-pore fungus" or the "volvate polypore." During the fall of 1911, the writer frequently found this species on fallen coniferous trunks. Since that time, many specimens of it have been collected. They were growing from such hosts as Douglas fir (*Pseudotsuga taxifolia*), the western hemlock (*Tsuga heterophylla*), and white fir (*Abies grandis*). During the months of March and April, 1912, I had the opportunity of observing quite thoroughly the development of the sporophores of this fungus, and a few words might be said here to supplement what Peck (3) has already said concerning some advanced stages of the pileus. Two trees of *Tsuga heterophylla* found on the campus at the University of Washington were thoroughly infected. This gave splendid opportunity to observe the sporophores in different stages.

The very young stages of the sporophores of *Cryptoporus* are globose and covered with a thick crust of reddish-brown resin exuded from the tree. As the button grows, this crust becomes thinner and thus the sporophore appears to grow lighter in color. Because of this coating of resin, no satisfactory method of killing and embedding for histological work was found. However, some free-hand sections were made and examined after staining with eosin. In the earlier stages the button is an undifferentiated mass of fungous filaments. The cortex is soft-fleshy, hygrophanous, and white. Soon a tiny spherical cavity appears in the center of the button, when the latter is from 3 to 4 mm. in diameter. This increases in size with the growth of the button and the fleshy tissue increases in thickness up to about 3 mm. Until the sporophore is about 12–20 mm. in diameter, the tissue is about the same

thickness above and below the cavity, but at this stage when the hymenium begins to form in the ceiling of the cavity, as it were, the portion above becomes thicker while the portion below (the volva) becomes thinner. Peck (3) says this portion above the pore-bearing layer is in two strata, an outer thicker one and an inner thin stratum. Just when these strata of the fundamental tissue are differentiated is not known. In these later stages an appendage appears inside of the volva and protruding from around the hymenophore. This has been figured by Peck (3) and is imperfectly shown in some of the sections in the accompanying plate. It is probable that this appendage is not a constant characteristic. In some specimens it does not extend wholly around the hymenophore but forms irregular, tuberculose projections. In other specimens it appears as a very low ridge encircling the pore-bearing layer. As the volva becomes thinner, it grows downward in the portion near the attachment of the sporophore. Here it becomes very thin and the ostiole of the volva is formed. This is always very close to the tree trunk.

Until nearly the time when the ostiole is formed, the whole sporophore is very fleshy and watery. Now it begins to shrink somewhat by the loss of water and the texture becomes soft-corky and still of a white color. The tubes become yellowish to almost cinnamon. The shrinking of the whole sporophore causes a cracking of the resinous crust, which often scales off. In the old sporophores this leaves the white surface glabrous, but often anastomosingly rimose. The development of the sporophore as observed from free-hand sections is illustrated by the series of median vertical sections on plate 159, while the mature sporophores with well-developed ostioles are shown on the same plate.

More detailed work on the development of this peculiar polypore should be done to determine the histological development and formation of (*a*) the primordium of the pore-cavity, (*b*) the primordium of the hymenium, (*c*) the thin interior stratum of the sporophore, of which the appendage mentioned above is the projecting edge, (*d*) the constancy of this projecting appendage, and (*e*) the ostiole of the volva.

Pure cultures of the fungus were made from the tissue of the young sporophores. Potato hard agar was used as a medium.

The mycelium grows abundantly in cultures, and in a period of four weeks conidiospores were formed. These varied from ellipsoid to pyriform in shape. They appear on short conidiophores from the clamp-connections which are abundant in the hyphae.

The first stages of sporophores were obtained in cultures. Small sticks of hemlock wood about one inch in diameter were cut so that they would stand erect in an Erlenmeyer flask. The borings of insects (to which reference is made later) were imitated by boring a small gimlet hole lengthwise following the pith

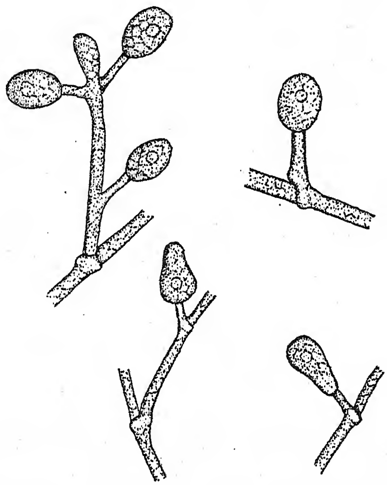

FIG. 1. Conidiospores formed in cultures of *Cryptoporus volvatus*.

of the stick. At right angles to this, other gimlet holes were bored, some near each end of the sticks. These sticks were put in flasks containing some agar and in such a way that some of the radial gimlet holes were just above the surface of the agar. After sterilization the agar was inoculated with *Cryptoporus* and the mycelium spread to the stick, entered the gimlet holes below, and emerged in the form of buttons above. These buttons grew in some cases to be 5–10 mm. in diameter but did not develop the internal cavity. The buttons formed in cultures were pure-white and without the ordinary coat of resin. The surface was perfectly even, dry, and glabrous.

The intimate relationship which exists between the attack of

timber by insects on the one hand and fungi on the other have been pointed out by several mycologists and entomologists. There are without doubt many fungi which follow the borings of insects. *Cryptoporus volvatus* is an example of this kind. It is found that a great many species of insects inhabit the pore-cavity. Hubbard (2) has dealt with the relation of insects to this fungus. The insects which wander in and out through the ostiole of the volva aid in the dissemination of the *Cryptoporus* spores. When the hymenium of the fungus begins to discharge spores the inside of the volva soon becomes covered with a heavy layer of spores and when the insects crawl in and out they take with them myriads of spores upon their bodies and appendages. Besides the large number of insects mentioned by Hubbard, the small fungus borer, *Sitodrepa panicea,* is found in nearly all of the mature sporophores and its borings in the tree extend quite a distance into the sapwood, where the insect would distribute the spores of the fungus.

This relationship of fungi and insects is surely significant in the dissemination of the spores of this fungus which has its fruiting surface so protected from other spore carriers, such as air currents, etc. However, it would be difficult to imagine that *Cryptoporus* is as dependent upon boring insects as suggested by House (1). He says that the volva aperture is the result of a boring weevil. This, however, is not consistent with the general appearance and development of the ostiole. During the stage of development when that portion of the volva had become thin and wholly vanished, with the exception of bits of the dead fundamental tissue, the writer has often cracked off the crust of resin from the under surface of the volva and thus disclosed a perfectly formed ostiole, through which no insect had ever passed. The margin of the ostiole is round and has the characteristic surface of the other portions of the fungus and very unlike the edge of a beetle boring. The ostiole of the volva of *Cryptoporus volvatus* is a morphological characteristic.

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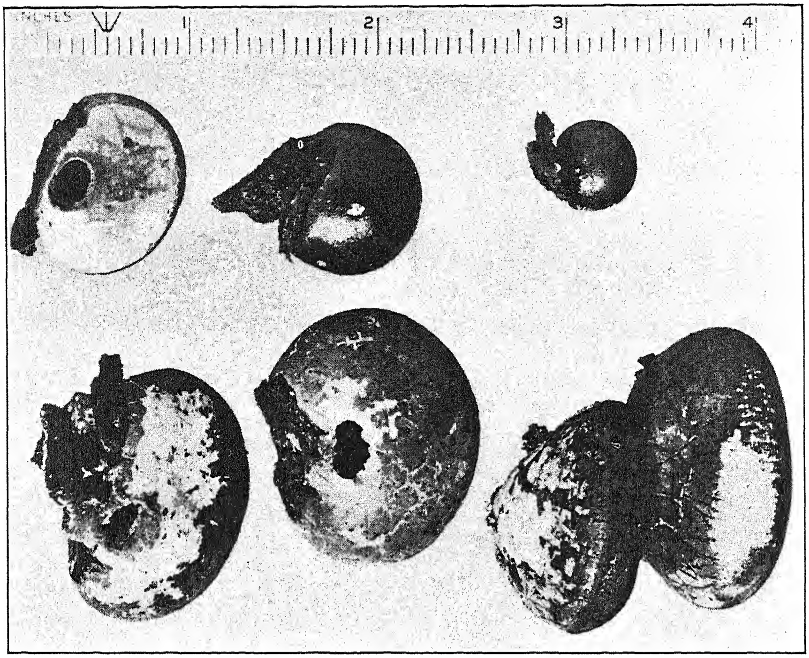

Fig. 1. SPOROPHORES OF CRYPTOPORUS VOLVATUS SHOWING OSTIOLE

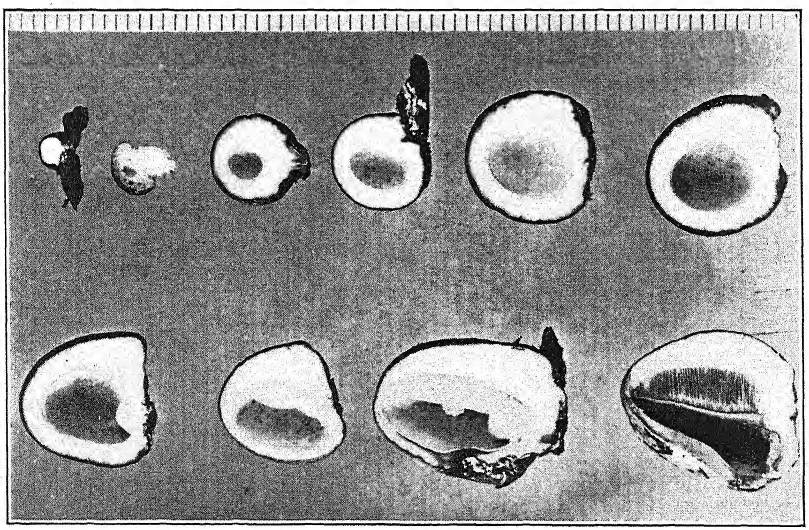

Fig. 2. SPOROPHORES OF CRYPTOPORUS VOLVATUS SECTIONED TO SHOW PORE-CAVITY

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DESCRIPTION OF PLATE CLIX

FIG. 1. Sporophores of *Cryptoporus volvatus* (Peck) Shear. The two smallest ones show the resinous coating completely covering the surface. The ostiole of the volva has not appeared in this stage. Others show the resinous coat partially cracked from the surface exposing the white fungal tissue. Dead fundamental tissue is left adhering to the margin of the ostioles.

FIG. 2. Stages in the development of the sporophores, showing the enlargement of the pore-cavity, the gradual formation of the hymenophore and the ostioles of the volva.

THE EFFECT OF CONTINUED DESICCATION ON THE EXPULSION OF ASCOSPORES OF ENDOTHIA PARASITICA

F. D. Heald and R. A. Studhalter

The importance of ascospore expulsion in the dissemination of the chestnut blight fungus has been emphasized by various writers since the process was first observed by Rankin. A brief consideration of the work bearing on this phenomenon is presented in the historical introduction to a recent article[1] and will not be repeated here.

The effect of continued desiccation on the expulsion of ascospores has an important bearing on dissemination, since chestnut products bearing perithecial stromata are frequently transported for some distance. If these products are dried, the question has been raised as to how long the perithecia will retain their power to eject spores if subjected again to favorable conditions of moisture and temperature.

Anderson and Babcock[2] first brought out the fact by laboratory tests that expulsion of spores is resumed after desiccation if moisture is supplied. The longest period of drying recorded in this first work was seven days and this appeared to have little or no effect on the power of the perithecia to expel spores. In a later article by Anderson and Rankin[3], the influence of long desiccation is reported as follows: "The writers also found that the perithecia will retain their ability to eject spores for at least seven

[1] Heald, F. D. & Walton, R. C. The expulsion of ascospores from the perithecia of the chestnut blight fungus, *Endothia parasitica* (Murr.) Anders. Am. Jour. Bot. 1: 499–521. *f. 1, 2.* 1914.

[2] Anderson, P. J. & Babcock, D. C. Field studies on the dissemination and growth of the chestnut blight fungus. Bull. Pa. Chest. Tree Blight Comm. 3: 1–45. 1913.

[3] Anderson, P. J. & Rankin, H. W. The Endothia canker of the chestnut. Bull. Cornell Agr. Exp. Sta. 347: 531–618. 1914.

months under perfectly dry conditions." No detailed description is given of the tests on which this statement is based.

Alternate drying and drenching of cankers is, of course, the normal condition in the field. Work to be reported later has brought out the fact that under these conditions given areas of the bark of cankers will continue to expel ascospores through all or at least parts of two seasons.

METHOD

Bark showing an abundance of mature perithecial stromata was collected at Emilie, Pa., on July 15, 1913. The bark was then moistened and tested to make sure that the perithecia were in a condition to expel spores.[4] As soon as any specimens showed expulsion of spores, they were allowed to dry. By July 21, 1913, all the specimens to be retained had been tested and were thoroughly dry. They were then grouped in packets of six specimens each, giving to each lot as near as possible uniform material. They were then stored in a closed pasteboard box and retained in the laboratory.

Each of the six pieces of bark in a packet was of sufficient size to support an object glass. Tests were made at about monthly intervals employing six pieces each time. The method employed was that previously described by Heald and Walton.[5]

RESULTS

The results obtained by the different tests can best be presented in tabular form (Table I). From this summary it may be noted that the perithecia still retained the power to expel spores after 11 months and 18 days of continuous drying. In all probability the limit was not reached, as the perithecia seemed to develop as strong powers of spore expulsion during the last test as in any of the earlier ones. In the majority of cases all of the pieces of bark tested showed active ostioles after being subjected to favorable conditions for a sufficient length of time, and there was

[4] The material was collected by Mr. R. C. Walton and some of the earlier tests were made by him.

[5] Loc. cit.

TABLE I

SUMMARY OF EFFECT OF DESICCATION ON ASCOSPORE EXPULSION

Period of Desiccation	No. of Pieces Showing Expulsion	Day of Test on Which 1st Expulsion Occurred	Day of Test on Which the the Last Trap Began to Show Active Ostioles	Maximum No. of Active Ostioles per Day on Any Trap	Duration of Test
1 mo., 13 days	5	2	11	100+	1 mo., 12 days
2 " 3 "	6	2	26	72	1 " 15 "
3 " 3 "	6	19	24	200+	1 " 3 "
4 " 7 "	5	21	58	200	2 " 18 "
5 " 9 "	6	23	54	200+	2 " 2 "
6 " 13 "	5	30	39	200	1 " 28 "
8 " 3 "	5	38	48	40	2 " 3 "
8 " 17 "	6	30	38	300+	1 " 20 "
9 " 14 "	6	20	29	250+	1 " 6 "
10 " 14 "	6	17	22	200+	1 "
11 " 18 "	6	18	21	250+	1 "

never more than one in any set in which no active ostioles were present. After one and two months of drying, certain perithecia began to expel spores on the second day of the test, but with longer desiccation the initiation of the process was considerably delayed, the number of days required varying from 17 to a maximum of 38. Even during the early part of the desiccation period

TABLE II

RECORD OF TYPICAL SPECIMENS SHOWING CHARACTERISTIC INCREASE IN THE ACTIVITY OF SPORE EXPULSION

No. of Day	Nos. of Specimens and the Number of Active Ostioles on Successive Days							
	339	345	347	373	384	387	393	394
1	4	3	3	7	2	10	15	12
2	5	4	2	24	20	30	18	30
3	11	9	6	50	30	90	42	52
4	13	32	16	85	60	250	80	78
5	28	35	23	80	65	250+	100	80
6	41	154	31	175	75	"	130	60
7	60	158	46	300	100	"	150	65
8	69	178	47	300+	100+	"	100	15
9	89	150	54	"	"	"	"	15
10	112	193	58	"	"	"	"	14
11	97	200+	63	"	150	"		17
12	68	200+	67	"	150+	"		13
13	119	"	61	"	"	"		
14	172	"	73	"		"		
15	126	"	76	"		"		

the beginning of spore expulsion was considerably delayed in some of the specimens. The day of the test on which the last

specimen showing expulsion began its activity varied from 11 to 58 days.

Many of the specimens showed a marked and characteristic increase in the number of active ostioles after the beginning of spore expulsion. There appears to be a gradual increase to a maximum of activity with more or less fluctuation after the maximum has been reached. This peculiarity is illustrated by the record for a number of typical specimens as presented in the accompanying table (Table II). In the majority of cases the record was not continued beyond the maximum of activity.

THE VIABILITY OF THE SPORES EXPELLED FROM DESICCATED PERITHECIA

The longevity of ascospores of the chestnut blight fungus has been reported from tests made on material stored under different conditions. According to Anderson,[6] ascospores ejected from perithecia on to glass slides continued viable for five months and six days, while Anderson and Rankin[7] report that spores taken directly from perithecia in desiccated bark retained the power to germinate for a much longer period. Their statements on this point are as follows: "At the end of one year very little diminution in the percentage of germination could be seen." "In another series of experiments a large percentage of ascospores similarly stored germinated after eighteen months." No germination tests were reported of spores expelled from desiccated perithecia, but judging from their results on spores taken direct from dried material, one would expect a good germination of spores expelled after a prolonged drying of the bark.

During the progress of the work on spore expulsion reported in this paper, germination tests of the expelled spores were made. In each determination the percentage of viable spores was determined in duplicate cultures by the hanging-drop method. A spore print from a given specimen was covered with sterile water and rubbed up with a sterile loop to secure a uniform suspension, and the culture made by transferring spores from this suspension

[6] Anderson, P. J. The morphology and life history of the chestnut blight fungus. Bull. Pa. Chestnut Tree Blight Comm. 7: 1–44. 1913.

[7] Loc. cit.

to dextrose agar. The results of these germination tests are shown in Table III. The slight reduction in germination per-

TABLE III

GERMINATION PERCENTAGES OF ASCOSPORES EXPELLED FROM DESICCATED BARK

Specimen Number	Period of Desiccation	Germination Percentages	Average Germination Percentages
341 341	5 mo., 9 days " "	98 98.5	98.25
345 345	5 mo., 9 days " "	86.75 85.8	86.27
349 349	6 mo., 13 days " "	59 63	61
350 350	6 mo., 13 days " "	81.5 84	82.25
373 373	8 mo., 17 days " "	69.7 68.9	69.3
392 392	10 mo., 14 days " "	50 29.16	36.58
393 393	10 mo., 14 days " "	78 77.8	77.9

centage is in agreement with the results reported by Anderson and Rankin for ascospores under the conditions of their tests.

CONCLUSIONS

Continued desiccation does not inhibit the power of the perithecia of *Endothia parasitica* to expel spores when subjected to favorable conditions of temperature and moisture. It does, however, lengthen the period from the beginning of favorable conditions to the first expulsion. On account of this fact, it does not seem probable that perithecial material which has been retained in a dry condition for three months or more would ever be subjected under natural conditions to favorable influences for a sufficient length of time to induce spore expulsion. Material dried for one or two months, might, however, be a source of danger, as more or less expulsion might be induced by natural agencies.

Spores expelled from desiccated perithecia show little or no reduction in the percentage of germination.

It seems probable from our results and from those of others already cited that the time limit of ability to expel ascospores was not reached in the tests here recorded.

LUMINESCENCE IN THE FUNGI

William A. Murrill

The phenomenon of phosphorescence, or luminescence, in living organisms has long been known and wondered at, but there remains much to be learned about the entire subject. The light-bearing fishes of the deep sea, the "sparkling" waves at the sides of a ship on a dark night, the firefly and glowworm, and luminous bacteria occurring on decaying fish, cabbage, etc., are well known. Molisch's bacteria lamp designed for mines and powder magazines was an attempt to put this process of slow oxidation to some practical use.

In animals, the light is usually brief and intermittent, while certain fungi may give off light continuously for days, weeks, or even months, so long as the light-giving cells are uninjured and active and water is present. This light-giving power is recognized as useful to animals, but is probably without biological significance in plants. One can hardly believe that the spores of *Clitocybe illudens,* for example, are distributed to any great extent by the moths and fireflies that happen to be attracted by the weird light emanating from its spore-bearing surface.

In some fungi, the power of luminescence is confined to the active cells of the mycelium. This is true in the case of *Armillaria mellea,* which inhabits old stumps and often causes them to glow on dark nights. While the rhizomorphs of this species are covered with active hyphae, they are luminous, but when they form a cuticle and enter the resting period the luminosity disappears. The mycelium of the hymenophore of this species is not luminous even when most active.

On the other hand, the sclerotia of *Collybia tuberosa* are said to be luminous; and the writer has observed that the mature hymenophores of *Panus stypticus* may be luminous when the young ones are not. *Xylaria Hypoxylon* is reported luminescent when growing naturally but not in pure cultures, which may pos-

sibly be due to the association of photogenic bacteria or other light-producing organisms.

It is impossible to give an accurate and complete list of the more conspicuous luminescent fungi, and some of the names recorded in the literature are very probably synonyms. Among North American species, the following have been reported to have the power to produce light, either in the mycelium or in some part of the fruit-body.

Armillaria mellea (Vahl) Quél.
Ceriomyces crassus Batt.
Clitocybe illudens (Schw.) Sacc.
Collybia longipes (Bull.) Quél.
Collybia tuberosa (Bull.) Quél.
Corticium coeruleum (Schrad.) Fries
Fomes annosus (Fries) Cooke
Laetiporus speciosus (Batt.) Murrill
Panus stypticus (Bull.) Fries
Polyporus caudicinus (Scop.) Murrill
Porodaedalea Pini (Thore) Murrill
Xylaria Hypoxylon Pers.

To the above preliminary and very incomplete notes, may be added a few simple observations made on *Clitocybe illudens,* the most conspicuous of our luminescent species. The writer has frequently collected the beautiful orange hymenophores in New York, Virginia, North Carolina, and other states, and almost invariably they have been found to be luminous. On August 21, 1911, at 8 a. m., I collected about two bushels of the hymenophores of this species from an old oak stump in a low, shady woodland east of Bronx Park and brought them to my office in a large basket covered with fresh ferns. Several specimens, including wood containing the mycelium, were taken into the dark room at 8:30 a. m., but they exhibited no luminosity. At 10 a. m., a large cluster was first tried in the dark room, then exposed to diffused sunlight for an hour, and afterwards heated to 90° C. in 7 minutes in a drying oven, and at no time did it become luminous.

At 11 a. m., a cluster was immersed in cool water and left there 20 minutes, but this did not make it luminous. The water, now colored pale-orange, was tested in the dark room, but showed no luminosity. It was not to be expected that either the dissolved

coloring matter or the mature spores held in suspension would possess photogenic properties.

At 1:30 p. m., the entire collection of hymenophores was taken from the herbarium to the dark room without removing them from the original basket, and no trace of light was observed during a period of 7 minutes. A piece of wood was then discovered in which the mycelium was evidently fresh and active, and this showed beautiful luminescence in a few seconds. On breaking this wood into pieces, the interior was even more luminous. Hymenophores were then broken apart and the mycelial cords at the base of the stipe exposed, with only negative results.

At 7:30 p. m., specimens taken from the herbarium to my home were tested in a dark closet in the presence of five people and in 1½ minutes the under surfaces of all the hymenophores were seen to glow conspicuously, while the upper surfaces remained dark. Water had no effect; dissolving out the coloring matter had no effect; and the colored liquid obtained was not luminous.

On August 22, at 8 a. m., I tried hymenophores of the same collection in the dark room at the Garden for 8½ minutes with entirely negative results, while wood containing the active mycelium was seen to glow distinctly within a minute or less. At 9 a. m., the specimens taken home the previous afternoon were examined in a dark closet and appeared luminous after 10 to 15 minutes. Pieces of wood containing the mycelium were found to glow promptly after lying in the herbarium all day.

At 9 p. m., the hymenophores at my home were again tested and luminosity was observed in 1 or 2 minutes. These specimens had been examined at 9 a. m. on the same day and during the evening of the previous day, lying meanwhile on a table in the living room.

On August 23, at 9:30 a. m., the wood containing mycelium, which had been lying on my desk in the herbarium, was found to be dry and no longer capable of luminescence. The observations were then discontinued.

NEW YORK BOTANICAL GARDEN.

THE PENICILLIUM LUTEUM-PURPUROGENUM GROUP[1]

CHARLES THOM

Wehmer[2] in a recent paper pointed out what he believes to be natural cleavage lines among the species commonly lumped together under the generic name of *Penicillium*. In that paper he reasserts the validity of his separation of *Citromyces* as a separate genus, transfers the coremiform species *P. claviforme* and *P. silvaticum* to the genus *Coremium* Link, incorrectly attributed to Corda, and revived for the purpose, and indicates the desirability of separating *P. brevicaule* and its allies without recognizing that this was done by Bainier[3] in 1907 under the name of *Scopulariopsis*.

The validity of the latter group has been amply confirmed by the work of Miss Dale,[4] whose cultures have been seen by the writer of this paper.

The application of the name *Coremium* to *P. claviforme* Bainier and *C. silvaticum* Wehmer is appropriate. Whether the botanical rules of nomenclature will permit such use is, however, very doubtful from the history of the name *Coremium* as given elsewhere.[5]

If the *Coremium* group were limited to the two species named, separation would be easy. However, *P. duclauxi* Delacroix

[1] Published by permission of the Secretary of Agriculture. This paper is a revision and extension of a paper read before the Botanical Society of America in Philadelphia, in December, 1914, under the title "The Penicillium Group Verticillatae of Wehmer."

[2] Wehmer, C. Ber. deut. Botan. Ges. 32 (1914), Heft. 5, pp. 373–384. *Coremium silvaticum* n. sp. nebst. Bemerkungen zur Systematik der Gattung *Penicillium*.

[3] Brainier, G. Bul. Soc. Myc. France, 23 (1907), p. 98.

[4] Dale, E. On the fungi of the soil. Ann. Mycol. 12 (1914), No. 1, pp. 33–62.

[5] Thom, C. Cultural Studies of Species of *Penicillium*, U. S. Dept. Agr. Bur. Anim. Ind. Bul. 118, Washington, 1910.

under some conditions of culture falls definitely within the *Coremium* group as used by Wehmer. Under other conditions it becomes a simple *Penicillium*.[6] *P. expansum* Link, observed upon a rotten apple, is usually typical for the genus *Coremium*, but when transferred to culture media becomes a *Penicillium* again, which under many cultural conditions shows no sign of coremia.

Sopp[7] has also definitely broken the penicillately fruiting organisms into several genera upon morphological lines.

The difficulties encountered in the use of either plan suggest the desirability of continuing the general use of the name *Penicillium* for the entire group until definite natural lines of cleavage can be established.

Penicillium, in the narrowest sense, as discussed by Wehmer, includes those forms which produce green mold surfaces consisting of a large number of separate conidiophores. Within this narrowest group he finds also natural cleavage lines which perhaps represent real relationship. He has pointed out one such natural group and suggested that it be called the Verticillatae. This section and a single series within this group form the subject of this paper. In the past ten years about fifteen members of this series have been collected from widely separated regions. Some of them, *P. luteum*, *P. africanum*, *P. pinophilum*, and *P. purpurogenum* were already named and described without indication of relationship. Several, for example, *P. africanum* and *P. purpurogenum*, among named forms, are closely enough related to make separation troublesome even to the describer.[8] When several other members of the series are added, the description of each in terms which will insure identification by the next worker becomes more difficult, perhaps impossible. Descriptions and figures for a series of these forms were prepared, laid away, then reread, and compared along with fresh cultures and accumulated cultural data. Some of these forms have been kept in continuous culture for about ten years. They maintain the individuality of old friends. Such strains are well established biological entities but to draw a tech-

[6] Thom, C. l. c.

[7] Sopp, O. Johan-Olsen. Monographie der Pilzgruppe, *Penicillium*, etc. Videnskapsselskapets Skrifter I. Mat.-Naturv Klasse 1912, No. 11, Christiana, 1912.

[8] Doebelt, H. Ann. Mycol. 7 (1909), No. 4, pp. 315–338.

nical characterization which will surely separate them is exceedingly difficult. The common morphological characters have, therefore, been brought together to define the section Verticillatae of the whole group of penicillate organisms in the sense of Wehmer. These characters follow:

MORPHOLOGICAL CHARACTERS OF SECTION VERTICILLATAE

Conidiophores vary greatly in length. Each conidiophore typically produces a crown or verticel of metulae,[9] or fertile branches. From this arrangement Wehmer derives the name Verticillatae. The metulae are few to many in the verticel; the number differs in the different members of the series. They are usually closely clustered. Careful search in nearly every strain shows an occasional conidial fructification in which a secondary verticel is borne either upon the main conidiophore prolonged through the center of the primary verticel or upon some one of the metulae of the primary series. Both conditions are found, but only in small numbers under the usual conditions of culture.

This section includes many species, some of which form series in which further relationship is suggested. Others diverge widely. One such series of forms has been collected and may be designated the luteum-purpurogenum series from the well known forms which stand at the extremes.

THE LUTEUM-PURPUROGENUM SERIES

At one end of this series stands a strain of *P. luteum*[10] Zukal which produces ascospores freely in all the media used and conidia very sparingly. In the actively growing culture the dominant shades of color are yellow with tardy appearance of red. At the other end stands *P. purpurogenum* Stoll,[11] which produces only conidia, in which yellow shows transiently, while red colors in mycelium and substratum are abundant.

[9] Westling, R. Arkiv. för Botanik. Bd. 11, No. 1, p. 44, in Ueber die grünen spezies der Gattung *Penicillium.*

[10] Described as *P. luteum* in Bul. 118, B. A. I. U. S. Dept. Agr. The culture was cultivated by Prof. R. Thaxter in 1905.

[11] Stoll, O. Beiträge zur Morphologischen and biologischen Characteristik von *Penicillium,* Inang. Dissert. Stuttgart 1903–4.

Among these forms is one well-marked organism (No. 2670) *P. purpurogenum* var. *rubri-sclerotium*, with all the common characters of the series but producing abundant sclerotia, dark-red to black in color, upon the surface of the substrata. If these sclerotia should be found to be undeveloped perithecia, the form would be clearly eliminated from genetic relationship to the forms at the luteum end of the series, but would probably take with it the other forms at the purpurogenum end of the series.

COLONY CHARACTERS

The production of yellow in the surface growth at some period of colony development or under some cultural conditions is typical for the group. This may be dominant, transient, or almost lacking yet it is not difficult to demonstrate in the organisms studied. Microscopic examination shows this color to be due to the encrustment of the aerial hyphae, or part of them, with yellow granules. Definite quantitative differences in this color are shown by successive cultures of the same strain in different media, especially in media with differing reaction. The different numbers of the series show fairly constant differences in the amount of yellow color produced. This quantitative difference is partly at least due to the characteristic differences in the amounts of surface mycelium produced by the different races. Color increases with floccosity. In *P. pinophilum*, Hedgcock[12] found that the color of the granule was yellow when acid, and a reddish shade when alkaline. In the strain of *P. luteum*, previously described (Bul. 118, Bur. Anim. Ind. U. S. Dept. Agr., No. 11), the yellow is a dominant factor during the early growth of the organism, giving place but partially to reddish hyphae in age. The whole culture gets its color from the yellow granules.

The descriptions of Wehmer[13] indicate the production of conidia much more abundantly by his strain of this species. The subsequent discovery of ascospores conforming to the descriptions of *P. luteum* in other American strains suggested the relationship of this whole series. The ascus-producing forms when brought together show a progressive loss in ascus producing

[12] Hedgcock, G. G. Missouri Bot. Garden, Rept. 17, pp. 105–107.

[13] Wehmer, C. Ber. deut. Botan. Gesellsc. 1893, p. 499.

power with progressive development of large conidial areas until we reach forms with few ascigerous masses. From these to the forms with no asci is the next natural step. This transition is suggested by the general morphology of certain forms on which asci have been produced in culture. In every member of the series careful observations show at least a narrow fringe of hyphae studded with yellow granules, about the margin of the developing colony. The yellow is quickly covered by the mass of green spores but usually may still be seen with the microscope.

COLOR IN THE SUBSTRATUM

Coincident with the change of color in the surface or aerial growth we find at the luteum end of the series that yellow to orange shades predominate in the substratum. These slowly or but partially change to red as the colonies become old. In the forms producing conidia only, yellow or orange tones still appear in the young colony. The change to red is slow and only partial in some forms but towards the purpurogenum end of the series the yellow colors are reduced to but transient appearances, replaced quickly and almost completely by red. Observations upon these changes must be repeated at intervals during a period of two to three weeks.

MORPHOLOGY

The members of this series show the conidiophore character of the whole section. Together with color production, however, they display an essential uniformity in sterigmatal and conidial characters, shared with some but not all the forms showing the conidiophore and branching described by Wehmer for the Verticillatae.

STERIGMATA

Each branch or metula bears at its apex a closely packed cluster of sterigmata[14] (syn. basidia, conidiiferous cells) or conidium-bearing cells. These are closely packed and continue as nearly parallel as mechanical conditions permit. They widen gradually

[14] The use of the term sterigmata here follows Westling who has discussed this series of terms fully, l. c., p. 47.

from the base upward for 5 to 8 μ, then taper slowly to the diameter of the conidium producing tube,[15] with a total length of from 10 to 15 μ. The length of these cells, their lanceolate or lance-acuminate form and closely parallel arrangement is characteristic for the whole group.

CONIDIA

The conidia arise as cylindrical cells which change usually through fusiform to elliptical or in some cases almost globose, with walls, when fully ripe, either smooth or delicately roughened, or sometimes both in the same culture. The fusiform to elliptical shapes are most common. Variation in size in the same strain and usually in the same culture is very marked. Even strains with conidia averaging small have some which reach the sizes shown by the larger spored forms. Very large single spores and chains of spores are abundant in some strains while rare, or perhaps absent in others. In forms where the conidia have been germinated under observation the conidia swell to these large sizes while germinating. Masses of conidia where present give some shade of green to that part of the colony.

It is, therefore, possible to bring this group together in such a way as to aid the worker in locating the strains found. Whether any one can so define the appearances of each of the separate strains as to ensure identification by others is doubtful. Perhaps for most purposes it is immaterial.

A synoptical arrangement of the strains considered in this paper has been prepared from cultures grown in Czapek's solution agar.[16] When incubated at 37° C. five strains failed to grow, namely, Nos. 2647, 3525.15, 3523.4y, 2751, and 4010.9. The other strains grew well at blood heat. The cultures which failed

[15] Thom, C. Conidium production in *Penicillium*. Mycologia 6 (1914) No. 4, pp. 211–215.

[16]

Distilled water	1,000 c.c.
Magnesium sulphate	0.5 gram
Dipotassium phosphate (K_2HPO_4)	1.0 "
Potassium chloride	0.5 "
Ferrous sulphate	0.01 "
Cane sugar	30.00 grams
Agar	15.00 "

to develop at 37° C. grew freely as soon as the temperature was lowered. These five strains were distributed through the luteum section of the group; all of the purpurogenum section grew well at blood heat. The arrangement of the forms in the series presents their natural relationship as far as such relationship is determinable. The inclusion and placing of *P. duclauxi* is more or less arbitrary and perhaps due only to superficial evidence. The correlation of colors, color changes, and morphology suggest that the other strains may be safely grouped about *P. luteum, P. rugulosum, P. pinophilum,* and *P. purpurogenum* without offering specific names at present for new species.

SYNOPSIS OF THE SERIES

A.[17] Growing colonies with prominently yellow areas and reverse yellow to orange slowly replaced by reds—Luteum Section.

B. Ascigerous masses found.

a. Ascigerous masses abundant, conidial fruits few, scattered; colonies when young predominantly citron-yellow to strontium-yellow (Ridgway XVI), becoming partially and tardily pale-flesh-color or flesh-color (Ridgway XIV); submerged mycelium and agar (reverse of colony), shading from yellow toward orange-red or red. *P. luteum* Zukal.[18] Cultures No. 11 from[18] Prof. Thaxter, Cambridge, Massachusetts, No. 3522.3 by Dr. J. R. Johnston from Puerto Rico soil.

aa. Ascigerous masses few, green conidial areas well developed with conidiophores more or less in tufts. Yellow color predominates at edge and about ascigerous masses. Reverse colors from yellow toward orange and red. Culture, Thom, No. 2751, sent by Prof. M. T. Cook, from New Jersey.

BB. Ascigerous masses not found.

b. Colonies with sterile areas citron or strontium-yellow and conidial areas changing to flesh-color in age, shading with the amount of green conidia from sea-foam or chartreuse-yellow through citron, lime or chrysolite-green to densely conidial areas near ivy-green (Ridgway XXXI).

c. With conidial areas in scattered tufts; culture from rotting apple.[19] Thom, No. 3525.95, Washington, D. C.

cc. With large more or less irregular green areas. Cultures 3525.15 from rotting apples, Washington, D. C.; Thom No. 4010.9 from Seattle, Washington.

[17] Correlative divisions are indicated by duplication of index letters *A, AA; c, cc,* etc.

[18] *P. luteum* Zukal, Sitzber. K. Akad. Wiss. (Vienna) Math. Naturw. Kl. XCVIII, p. 521, 1889. Cultural description, Thom, C., U. S. Dept. Agr., Bur. Anim. Ind. Bul. 118, p. 39.

[19] Organisms from rotting apples were contributed by Mr. Brooks of the Bureau of Plant Industry.

ccc. With yellow area restricted to a narrow zone shading quickly to ivy-green. Culture Thom No. 3523.4y from Virginia soil.

bb. Colonies showing yellows above only in age, in reverse slowly but deeply orange to red. Conidia rough.

d. Without coremia—*P. rugulosum.*[20]

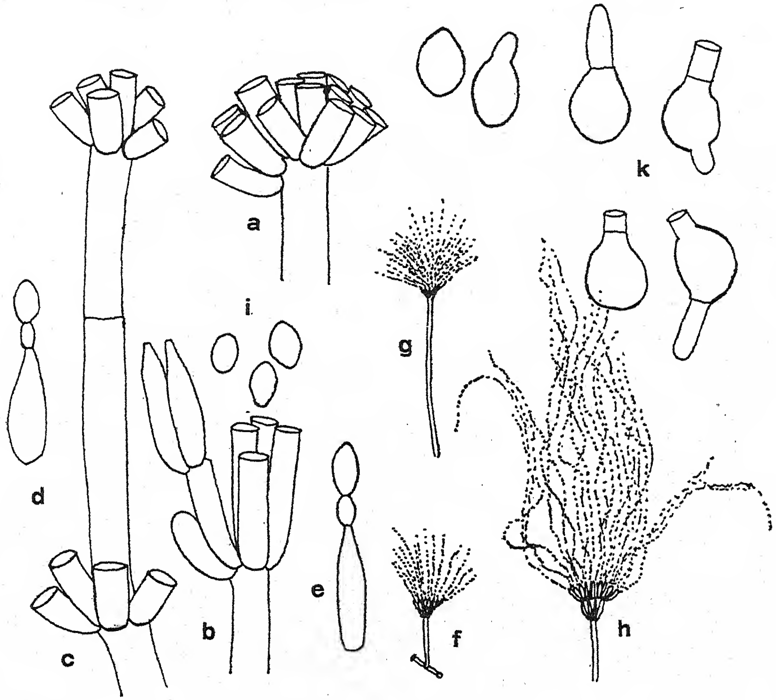

FIG. 1. *Penicillium purpurogenum* var. *rubri-sclerotinum.* *a, b,* typically verticillate branching at the apex of the conidiophore; *c,* in this conidial fructification the main axis is prolonged to bear a secondary verticel above the first; *e, d,* conidia bearing cells or sterigmata; *i,* conidia; *f, g, h,* diagrammatic representation of the entire conidial apparatus; *k,* germination of conidia. The morphology represented here shows the essential features of the entire group. In some the conidial chains are massed into solid columns, in others as in this divergent.

dd. With numerous long coremia—*P. duclauxi.*[20]

AA. Conidial areas prominent from the first. Reverse colors predominantly red. Pinophilum-purpurogenum section.

C. Colonies develop yellow and green areas together, which remain more or less persistently mixed.

[20] Thom, C., l. c. p. 60 and p. 42. The relationship of these organisms to each other and to the other members of the group may only be superficial but this necessitates their citation here.

e. Conidia rough; cultures 2647 and 2733 from English soil[21] and 2500 from New York soil.

ee. Conidia smooth, yellow hyphae becoming reddish in age, reverse and agar from salmon-orange to mahogany-red.

f. Floccose or tufted. *P. pinophilum* Hedgcock.[22] Numerous cultures obtained from soil and from food products can not be separated from this species.

ff. Velvety, broadly speaking. Thom No. 43.

CC. Growing colonies with margin variously changing through sea-foam green, chartreuse-yellow, or chrysolite-green (Ridgway XXXI), replaced by conidial areas toward celandine-green or andover-green (Ridgway XLVII). Reverse in reds toward oxblood-red (Ridgway I). Deep-red sclerotia developed in age. *P. purpurogenum*, var. *rubri-sclerotium*, var. nov.[23] This organism has been obtained from many sources and widely separated sections of the United States.

CCC. Colonies showing little or no yellow at first, yellow hyphae appear frequently in secondary growths in the centers or margins of older colonies. Reverse colors intensely red.

g. Conidiophores mostly borne as branches from interlacing aerial hyphae and ropes of hyphae.

h. Conidial fructification typically verticillate. *P. africanum* Doebelt, Ann. Mycol. 7 (1909) No. 4, pp. 315–338.

hh. Conidial fructifications branched several times. *P. funiculosum*, Thom, l. c., p. 70.

gg. Conidiophores arising as branches from separate hyphae. Complex ropes not found.

P. purpurogenum O. Stoll.[24]

Cultures have been found from American sources, especially several from corn (*Zea Mays*) which cannot be separated by satisfactory marks from the original strain distributed by Kral. The species is probably cosmopolitan.

BUREAU OF CHEMISTRY,
U. S. DEPT. OF AGRICULTURE.

[21] Contributed by Miss E. Dale, Cambridge, England.

[22] Thom, C., l. c. p. 31.

[23] *P. purpurogenum* var. *rubri-sclerotium*, var. nov. Differs from typical description of the species in the production of dark-red sclerotia on the surface of the substratum and in the well marked zone of yellow at the margin of the growing colony. It appears to be a soil fungus with well marked characters.

[24] The nomenclature of this form is discussed by Thom, l. c. p. 36.

STUDIES IN PORTO RICAN PARASITIC FUNGI—I

Esther Young

The present paper is a report of the results of a study of the genus *Phyllosticta* as represented in Porto Rico, Desecheo, and Mona Islands. The material studied is from the collection of Dr. F. L. Stevens, and each specimen examined is reported under the original number. The specimens were all collected by Dr. Stevens in the years 1912 and 1913. The original collection was divided into two portions, one being left with the College of Agriculture and Mechanic Arts at Mayaguëz, Porto Rico, and the other donated to the University of Illinois. In my studies I have made use of the material in the collection of the University. The type specimen is in each instance indicated by its original number, and is deposited in the herbarium of the University of Illinois, and a duplicate cotype is also deposited with the New York Botanical Garden. In cases where the collection was reasonably large, the surplus cotype material is placed in the herbarium of the University. Occasional notes have been added by Dr. Stevens concerning local distribution, etc.

I hesitate somewhat to describe these new species as belonging to *Phyllosticta* rather than *Phoma,* since I believe there is no tenable distinction between these genera. However, since it is customary to regard the forms on leaves as belonging to *Phyllosticta,* probably no good would be done by breaking over that custom in this instance. The final designation of these and related forms must be made after a monographic study of the genus.

The writer is under obligations to Dr. F. L. Stevens, under whose direction the work was done, whose many kindnesses and suggestions have made this publication possible. Expressions of appreciation are also due to Dr. N. L. Britton, Mr. Percy Wilson, and Miss Margaret Slosson, of the New York Botanical Garden, and to Mrs. Agnes Chase, of the Bureau of Plant Industry, for assistance in determining host-plants.

1. **Phyllosticta adianticola** sp. nov.

Spots amphigenous, ovate to ovate-cuneiform, often acute at the basal ends, 4–12 mm. in diam., older portions ashen-gray, 1–2 × 2–4 mm., border yellowish-brown; pycnidia few, epiphyllous, brown, spherical, 72–120 μ in diam., ostiole distinct, dark-bordered, 12 μ in diam., conidia hyaline, ovate, slightly pointed at one end, 4.8–7.2 × 2.4 μ.

On leaves of *Adiantum tenerum* Sw. in Porto Rico: Manati, *4299* (type); Utuado, *4588;* Quebradillos, *5000*.

Apparently very common in all parts of the island of Porto Rico, though with very sparse pycnidia. This species is accompanied by a species of *Melanomma*.

2. Phyllosticta Sacchari Speg. Rev. Facult. Agr. Veter. La Plata **1896**: 239. 1896

On *Saccharum* in Porto Rico. Juana Diaz, *102*.

3. **Phyllosticta Panici** sp. nov.

Spots indefinite, diffuse; pycnidia few, often in clusters, epiphyllous, dark-brown to black, spherical, 72–144 μ in diam., mycelium a brown mass of septate hyphae; conidia hyaline, ovate, 4.8–9.6 × 3.6 μ.

On leaves of *Panicum maximum* Jacq. in Porto Rico: Coamo, *830* (type); Martin Pena, *Heller 377*.

4. Phyllosticta Colocasiae Höhnel, Sitz.-ber. Akad. Wiss. Wien. **116**: 142. 1907

On *Dieffenbachia* in Porto Rico: Monte de Oro near Cayey, *5670*.

5. Phyllosticta colocasicola Höhnel, Sitz.-ber. Akad. Wiss. Wien **116**: 142. 1907

On *Colocasia* in Porto Rico: Caguas, *504*.

6. **Phyllosticta commelinicola** sp. nov.

Spots indefinite, diffuse; pycnidia subepidermal, numerous on the upper surface, light-brown, 96–168 μ in diam., ostiole distinct, dark-bordered, 24–48 μ in diam.; conidia hyaline, ovate, 9.6–14.4 × 4.8–7.2 μ.

On leaves of *Commelina nudiflora* L. in Porto Rico: Hormigueros, *214* (type).

7. PHYLLOSTICTA COCCOLOBA Ellis & Ev. Ann. Rep. Missouri Bot. Gard. 9: 118. 1898

On *Coccoloba* in Porto Rico: Mona Island, *6240*, *6168*.

In our specimens, the spots and spores differ somewhat from those of the description, the spots being larger and reddish-purple becoming gray in the center. The spores are shorter, measuring 2.4–4.8 × 2.4 μ.

8. Phyllosticta momisiana sp. nov.

Spots diffuse, sordid-white to yellow, margin indefinite, mostly affecting the apical and marginal portions of the leaf; pycnidia numerous, epiphyllous, dark-brown, spherical, 48–60 μ in diam., ostiole distinct; conidia hyaline, ovate, 4.8–7.2 × 2.4 μ.

On leaves of *Momisia iguanaea* (Jacq.) Rose and Standley in Porto Rico: Coamo, *834* (type).

9. Phyllosticta Pithecolobii sp. nov.

Spots amphigenous, subcircular to ovate, 5–10 mm. in diam., yellowish-brown to white in the center, margin slightly raised and darker, dark-brown below; pycnidia located mostly along the nerves, numerous on the upper surface, densely clustered, few below, spherical, regular, dark-brown, 120–240 μ in diam., ostiole distinct, dark-bordered, 24 μ in diam.; conidia hyaline, ovate, pointed at one end, 4.8–7.2 × 1.8–2.4 μ.

Very common wherever the host was seen.

On leaves of *Pithecolobium Unguis-cati* (L.) Benth. in Porto Rico: Desecheo, *1576* (type); Yauco, *3267*.

Phyllosticta Pithecolobii monensis var. nov.

Spots very much like those of the species but smaller, being 3–5 mm. in diam., margin darker and more regular; pycnidia smaller, 48–120 μ in diam.; conidia ovate, rounded at the ends, 4.8 × 2.4 μ.

On leaves of *Pithecolobium Unguis-cati* (L.) Benth. in Porto Rico: Mona Island *6137* (type).

It is perhaps significant that the host on Mona Island was of the thornless form. Though systematists do not recognize this as a distinct variety or species, the fungus upon it is distinctly different from that found on the excessively spiny Porto Rican form of host.

10. PHYLLOSTICTA DIVERGENS Sacc. Malpighia 5: 281. 1891

On fruit of *Albizzia Lebbeck* (L.) Benth. in Porto Rico, *1875*.

This fungus is probably *Phyllosticta divergens* Sacc., which is reported on the leaves of this host, though there is no definite spot on the fruit as is described on the leaves. The conidia agree in length with those described but are narrower.

11. **Phyllosticta guanicensis** sp. nov.

Spots scattered, amphigenous, round, 1–2 mm. in diam., yellowish-brown with a reddish-brown slightly raised margin; pycnidia epiphyllous, few, scattered, spherical, 96–120 μ in diam., ostiole distinct, 12–15.8 μ in diam.; conidia hyaline, spherical to ovate, somewhat irregular, granular, 4.8–9.6 $\times$ 4.8 μ.

On leaves of *Guilandina crista* (L.) Small in Porto Rico: Guanica, *359* (type).

12. **Phyllosticta erythrinicola** sp. nov.

Spots few to numerous, scattered, small, circular, amphigenous, sordid-white, margin definite, regular, the brown centers falling out with age, portion of the leaf about the spot yellowish-brown; pycnidia epiphyllous, scattered, dark-brown, spherical 36–72 μ in diam., ostiole very dark, indistinct; conidia hyaline, ovate, minute, 2.4–3.6 $\times$ 1.2 μ.

On leaves of *Erythrina micropteryx* Poepp. in Porto Rico: Villa Alba, *110* (type); Jajome Alta, *5633;* Yauco, *3157;* Mayagüez, *68*.

Very common in all parts of the island, causing serious spotting of the foliage.

This species is distinct from *Phyllosticta Erythrinae*, which is reported on the branches of *Erythrina Lithospermae*. The pycnidia described are much larger, 90–180 $\times$ 60–70 μ, and lenticular in shape; the conidia were described as linear-ovate, 6–8 $\times$ 2 μ.

13. **Phyllosticta portoricensis** sp. nov.

Spots amphigenous, small, grayish becoming reddish-brown, circular to ovate, margin even, somewhat darker; pycnidia epiphyllous, few, scattered, dark-brown, spherical, regular, darker around the border, 60–90 μ in diam., ostiole distinct, 24–30 μ in diam.; conidia hyaline, subspherical to ovate-oblong, 9.8–14.4 $\times$ 4.8–7.2 μ.

On leaves of *Croton lucidus* L. in Porto Rico: Guanica, *325* (type).

14. PHYLLOSTICTA CISSICOLA Speg. Anal. Mus. Nac. Buenos Aires III. **13**: 332. 1910

On *Cissus sicyoides* L. in Porto Rico: Vega Baja, *382;* Jajome Alta, *5633a.*

15. **Phyllosticta Stevensii** sp. nov.

Spots amphigenous, irregularly circular, 4–12 mm. in diam., sordid-white to yellowish-brown above, indefinite below, reddish-brown where appearing, margin distinct, irregular, dark-brown; pycnidia epiphyllous, numerous, dark-brown, spherical to ovate, dark-bordered, 96–144 μ in diam., ostiole distinct, 24 μ in diam.; conidia hyaline, ellipsoidal, pointed at both ends, 7.2–14.4 $\times$ 2.4 μ.

On leaves of *Triumfetta semitriloba* Jacq. in Porto Rico: Coamo, *119*, (type); Villa Alba, *94*.

16. **Phyllosticta borinquensis** sp. nov.

Spots amphigenous, numerous, yellowish-brown in the center, becoming darker nearer the margin, circular to ovate, 2–5 mm. in diam., margin rather irregularly angular; pycnidia epiphyllous, scattered, dark-brown, spherical, regular, 48–70 μ in diam., ostiole dark-bordered, 12 μ in diam.; conidia hyaline, ovate, 2.4–4.8 $\times$ 1.2–2.4 μ.

On leaves of *Helicteres jamaicensis* Jacq. in Porto Rico: San German, *5672* (type).

Associated with this is one of the Sphaeriaceae, with dark-brown, spherical perithecia, 96–120 μ in diam. A mycelium of brown hyphae seems to connect the perithecia and pycnidia; asci stalked; spores eight in an ascus, septate, ovate, olivaceous, 4.8–7.2 $\times$ 2.4 μ. Owing to the fact that the spores were immature, it

was impossible to determine the genus with any degree of certainty.

17. **Phyllosticta bixina** sp. nov.

Spots yellowish-brown, scattered, subcircular to irregular, 5–10 mm. in diam., numerous, amphigenous, lighter below, often bordered by an intermediate yellow region which spreads over the leaf, older portions of the spot bordered by a distinct brownish-black margin; pycnidia few, epiphyllous, spherical, dark-brown, 92–148 μ in diam., ostiole distinct, dark-bordered, 12–24 μ in diam.; conidia hyaline, ovate, 4.8–6 $\times$ 2.4 μ.

On leaves of *Bixa orellana* L. in Porto Rico: Maricao, *174* (type); San German, *5794;* Rosario, *4844;* Mayagüez, *298;* Coamo, *53;* Punta Santiago, *2458;* Añasco, *3208;* Adjuntas, *4975a*.

18. PHYLLOSTICTA EUPATORICOLA Kab. & Bub. Hedwigia **46**: 288. 1907

On *Eupatorium odoratum* L. in Porto Rico: Villa Alba, *103*.

19. **Phyllosticta Eugeniae** sp. nov.

Spots amphigenous, circular, 2–4 mm. in diam., somewhat darker above than below, the center dark-brown surrounded by a lighter colored ring which is bordered by an even, dark, slightly elevated margin, centers falling out with age, leaf around the spot reddish-brown; pycnidia more numerous on the upper surface, dark-brown, spherical to ovate, 84–144 μ in diam.; conidia ovate, hyaline, granular, often remaining attached to their stalks, 9.6–16.8 $\times$ 4.8–6 μ.

On leaves of *Eugenia buxifolia* (Sw.) Willd. in Porto Rico: Mona Island, *6230* (type), *6091*, and *6127*.

An ascomycete is associated with this species. Perithecia amphigenous, dark-brown to black, spherical, regular, dark-bordered, 168–228 μ in diam., ostiole often opening laterally; spores hyaline, immature.

20. **Phyllosticta araliana** sp. nov.

Spots amphigenous, yellowish-brown, circular to ovate, 4–8 mm. in diam., bordered by a dark-brown, regular margin; pycnidia scattered, epiphyllous, spherical, 24–48 μ in diam., dark-

brown; conidia hyaline, ovate, slightly pointed at one end, 7.2–9.6 × 2.4 μ.

On leaves of *Dendropanax arboreum* (L.) Dec. & Pl. in Porto Rico: Maricao, *755* (type).

21. PHYLLOSTICTA GUAREAE P. Henn. Hedwigia **41**: 113. 1902.

On *Guarea trichiloides* L. in Porto Rico: Aquas Buenas, *295*.

22. **Phyllosticta Sechii** sp. nov.

Spots amphigenous, irregular or confluent, varying from 2 to 15 mm. in diam., sordid-white above, darker below, margin distinct, slightly raised, concolorous; pycnidia epiphyllous, numerous, dark-brown, spherical, 72–96 μ in diam., ostiole distinct, dark-bordered, 24–48 μ in diam.; conidia hyaline, ovate, slightly pointed at one end, 7.2–9.6 × 2.4 μ.

On leaves of *Sechium edule* (Jacq.) Sev. in Porto Rico: Mayagüez, *3357* (type).

This species differs from *Phyllosticta Lagenariae* Passer in the size and shape of the conidia, these being described as oblong, rounded at the ends, 10–12.5 × 5 μ.

23. PHYLLOSTICTA GLAUCISPORA Delacr. Bull. Soc. Myc. Fr. **9**: 216. 1893

On leaves of *Urechites lutea* Britton in Porto Rico.

In our specimens the spores are somewhat larger than those of typical specimens, measuring 4.8–9.6 × 2.4 μ. *Phyllosticta nericola* has hyaline spores, 8–10 × 3 μ, and differs only in color and a slight variation in the size of the spore. This species is distinct from *Phyllosticta Nerii* in the size of spores, those being much larger, 15–18 × 5–6 μ.

Associated with this is an undescribed species of *Colletotrichum* having perithecia surrounded with setae, and with hyaline, ovate-oblong spores.

24. PHYLLOSTICTA IPOMOEAE Ellis & Kellerman, Jour. Myc. **3**: 102. 1887

On *Exogonium repandum* (Jacq.) Choisy in Porto Rico: Manati, *5313*; Mayagüez, *20*; Rio Piedras, *5772*; Dos Bocas below Utuado, *6600*.

25. **Phyllosticta pandanicola** sp. nov.

Spots amphigenous, scattered over the leaf, grayish-white to light-brown, margin slightly darker; pycnidia located mostly along the nerves, epiphyllous, numerous, spherical to ovate, 80–100 × 50–60 μ., dark-brown, ostiole definite; conidia elliptical, pointed at both ends, hyaline, 96–144 × 2.4–3.6 μ.

On leaves of *Pandanus* sp. indet. in Porto Rico: Santurce, *240* (type).

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FUNGI EDIBLE AND POISONOUS

William A. Murrill

An article on this subject prepared by the writer appeared nearly a year ago in the fourth volume of the second edition of "Wood's Reference Handbook of the Medical Sciences." The plan of the article included a general introduction to edible and poisonous mushrooms; a list of edible mushrooms selected by Dr. Peck after nearly fifty years' experience; preparing and cooking mushrooms; descriptions of edible and poisonous species; and a brief glossary containing the technical terms used. In addition to the 23 pages of descriptive matter, 26 species are illustrated with ordinary half-tones and 22 with colored half-tones.

The edible and poisonous species described in this paper are carefully selected with special reference to their economic use or their dangerous properties. A number of species are omitted because they might be confused with poisonous species. Following the scientific description in each instance, are notes calling attention to special characteristics, occurrence, methods of cooking, etc.

No attempt is made to prepare a key to the species, since reliable keys are possible only when all the known plants of a group or of a region are included. The arrangement of the species follows the lines of classification adopted by the best authorities.

List of Species Described

Morchella esculenta Pers. Edible
Clavaria flava Schaeff. Edible
Hydnum repandum L. Edible
Hydnum Caput-ursi Fries. Edible
Fistulina hepatica (Huds.) Fries. Edible
Grifola frondosa (Dicks.) S. F. Gray. Edible
Laetiporus speciosus (Batt.) Murrill. Edible
Tylopilus felleus (Bull.) P. Karst. Inedible
Ceriomyces crassus Batt. Edible

Ceriomyces scaber (Bull.) Murrill. Edible
Ceriomyces ferruginatus (Batsch) Murrill. Poisonous
Ceriomyces miniato-olivaceus (Frost) Murrill. Poisonous
Suillellus luridus (Schaeff.) Murrill. Poisonous
Rostkovites granulatus (L.) P. Karst. Edible
Strobilomyces strobilaceus (Scop.) Berk. Edible
Chanterel Chantarellus (L.) Murrill. Edible
Chanterel aurantiacus (Wulf.) Fries. Doubtful
Lactaria deliciosa (L.) Fries. Edible
Lactaria lactiflua (L.) Burl. Edible
Lactaria piperata (L.) Pers. Edible
Russula Mariae Peck. Edible
Russula emetica Fries. Poisonous
Russula virescens (Schaeff.) Fries. Edible
Russula foetens Pers. Poisonous
Marasmius oreades (Bolt.) Fries. Edible
Pleurotus sapidus Kalchb. Edible
Clitocybe multiceps Peck. Edible
Clitocybe illudens (Schw.) Sacc. Poisonous
Melanoleuca personata (Fries) Murrill. Edible
Armillaria mellea (Vahl) Quél. Edible
Lepiota procera (Scop.) Quél. Edible
Lepiota americana Peck. Edible
Lepiota naucina (Fries) Quél. Edible
Chlorophyllum Molybdites Massee. Poisonous
Vaginata plumbea (Schaeff.) Murrill. Edible
Vaginata agglutinata (Berk. & Curt.) O. Kuntze. Poisonous
Venenarius phalloides (Fries) Murrill. Deadly poisonous
Venenarius muscarius (L.) Earle. Deadly poisonous
Venenarius cothurnatus (Atk.) Murrill. Poisonous
Venenarius spretus (Peck) Murrill. Poisonous
Venenarius solitarius (Bull.) Murrill. Poisonous
Venenarius rubens (Scop.) Murrill. Edible
Venenarius Caesareus (Scop.) Murrill. Edible
Pleuropus abortivus (Berk. & Curt.) Murrill. Edible
Pluteus cervinus (Schaeff.) Fries. Edible
Paxillus involutus (Batsch) Fries. Edible
Inocybe infida (Peck) Earle. Poisonous
Pholiota candicans (Bull.) Schröt. Edible
Hypholoma appendiculatum (Bull.) Quél. Edible
Hypholoma perplexum (Peck) Sacc. Edible
Agaricus campester L. Edible
Agaricus placomyces Peck. Edible
Agaricus arvensis Schaeff. Edible
Coprinus micaceus (Bull.) Fries. Edible
Coprinus atramentarius (Bull.) Fries. Edible
Coprinus comatus (Muell.) Fries. Edible
Lycoperdon gemmatum Batsch. Edible
Lycoperdon cyathiforme Bosc. Edible

Scleroderma aurantium (L.) Pers. Inedible
Dictyophora duplicata (Bosc) Ed. Fisch. Considered poisonous

PREPARING AND COOKING MUSHROOMS

The following directions are given in this article for preparing and cooking mushrooms:

Reject old specimens or those infected with insects, cut off the stems except in rare cases when they are unusually tender, peel a few kinds that seem to require it, wash quickly in cold water, drain and keep in a cool place until ready to cook. As a rule, mushrooms cannot be kept very long in a fresh condition, and this is particularly true of certain very desirable species. When more are collected than can be used at once, it is best to boil them ten minutes, drain, keep in a cool place, and finish the cooking next day as desired. If allowed to stand in water, the flavor is impaired; also, peeling may remove some of the best flavored parts.

The flavor and digestibility of mushrooms depend very largely on the way they are cooked. Tender varieties should be cooked quickly and served at once; tough varieties require long, slow cooking. When the flavor is good, it should be retained by covering during the cooking process and seasoning in a simple way. When the flavor is poor or when the specimens are slightly bitter or otherwise objectionable in the raw state, they may often be greatly improved by boiling for a short time and throwing the water away, then cooking thoroughly and seasoning well. It is often desirable to mix a few highly flavored specimens with those lacking flavor. Mushrooms are also excellent cooked with meat, poultry, oysters, tomatoes, or sweet peppers, and as a flavoring for soups and sauces.

Detailed directions for cooking mushrooms are given in most of the books. The most practical and successful methods resolve themselves into broiling, baking, and stewing. In the first, which I prefer to all other methods, the mushrooms are cooked thoroughly but as quickly as possible, on both sides over a hot fire; seasoned with pepper, salt, butter, and perhaps small bits of toasted bacon; and served hot on toast. To bake mushrooms, line the pan with toast, add the specimens, season, pour in half a cup of cream, cover closely, and bake rather slowly for fifteen

minutes or more according to quality. In stewing, the mushrooms are boiled in water until thoroughly cooked, then seasoned, thickened, and served on toast. This last method is often used for the tougher or poorer varieties. Certain modifications of the above methods may be suggested later under individual species requiring special treatment.

NEW YORK BOTANICAL GARDEN.

NEWS, NOTES, AND REVIEWS

"Western Polypores," by W. A. Murrill, was issued March 25, 1915. It contains descriptions of the pileate species occurring in California, Oregon, British Columbia, and Alaska, together with descriptive notes and complete keys to the genera and species. *Polyporus McMurphyi, Polyporus Zelleri, Inonotus Leei, Pyropolyporus Abramsianus,* and *Elfvingia Brownii* are described as new, while *Scutiger hispidellus* (Peck) and *Fomes amarus* (Hedgcock) are newly combined. *Crytoporus volvatus* appears in this work as the only representative of a new tribe, the Volvatae, characterized by the presence of a volva. The polyporaceous flora of the Pacific coast has been until recently very imperfectly known, and much field work still remains to be done in many parts of the region.

A paper on the Polyporaceae of Wisconsin, by J. J. Neuman, containing 156 pages of text and 25 plates, has just appeared as Bulletin 33 of the Wisconsin Geological and Natural History Survey. The family is treated in the broadest Friesian sense, including *Solenia, Porothelium, Merulius, Gloeoporus, Fistulina,* and the Boletaceae, in addition to the true polypores. The brief descriptions of species are accompanied by quite complete and helpful notes on habitat, occurrence, and relationship. Several introductory pages are specially devoted to species destructive to timber trees in the Wisconsin forests. Of the true polypores, over one hundred are recorded for the state. The author proposes one new variety, *Fomes nigricans populinus,* which might better have been based on *Fomes igniarius.* The plates add to the value of the work for purposes of identification, although most of them are, unfortunately, rather poor reproductions.

Russula and Marasmius in North American Flora

Volume 9, part 4, of *North American Flora,* by Gertrude S. Burlingham, William A. Murrill, and Leigh H. Pennington, ap-

peared April 30, 1915. The contents of the part may be indicated as follows:

Genera	Total Species	New Species
Russula	115	17
Schizophyllus	1	
Pleurotopsis	5	1
Scytinotus	3	1
Resupinatus	13	3
Marasmiellus	3	2
Panellus	10	3
Tectella	1	
Heliomyces	12	10
Marasmius	153	48
Polymarasmius	3	1
Crinipellis	7	4
Lentinus	18	2
Lentinula	1	
Lentinellus	1	
Lentodium	2	
	348	92

For the accommodation of those preferring currently accepted generic names, the following new combinations are proposed for species described as new in *Pleurotopsis, Scytinotus, Resupinatus, Marasmiellus, Panellus, Polymarasmius,* and *Crinipellis:*

PLEUROTOPSIS NIDULIFORMIS = **Marasmius niduliformis**
SCYTINOTUS DISTANTIFOLIUS = **Marasmius distantifolius**
RESUPINATUS CUBENSIS = **Pleurotus cubensis**
RESUPINATUS SUBBARBATULUS = **Pleurotus subbarbatulus**
RESUPINATUS ORIZABENSIS = **Pleurotus orizabensis**
MARASMIELLUS INCONSPICUUS = **Marasmius inconspicuus**
MARASMIELLUS JUNIPERINUS = **Marasmius juniperinus**
PANELLUS JALAPENSIS = **Panus jalapensis**
PANELLUS SUBCANTHARELLOIDES = **Panus subcantharelloides**
PANELLUS FLABELLATUS = **Panus flabellatus**
POLYMARASMIUS SUBMULTICEPS = **Marasmius submulticeps**
CRINIPELLIS SUBLIVIDA = **Marasmius sublividus**
CRINIPELLIS ALNICOLA = **Marasmius alnicola**
CRINIPELLIS SQUAMIFOLIA = **Marasmius squamifolius**
CRINIPELLIS ECHINULATA = **Marasmius echinulatus**

The largest tribe of the Agaricaceae, the Agariceae, is divided into four subtribes: the Lepiotanae, or white-spored series; the

Pluteanae, or rosy-spored series; the Pholiotanae, or rusty-spored series; and the Agaricanae, in which the spores are brown or black in mass. Two new genera are included, *Marasmiellus* and *Polymarasmius*, each with three species. Another new genus of the Lepiotanae, *Lentodiellum*, containing a single tropical species, occurs in the key but the description had to be reserved for the first page of Volume 9, part 5.

W. A. MURRILL.

THE VALIDITY OF CLITOCYBE MEGALOSPORA

The writer has recently had an opportunity to examine the type specimen of *Clitocybe megalospora* Clements (Bot. Surv. Neb. 4: 18. 1896), which was collected on wet earth at Saltillo, Nebraska, July 7, by Pound and Clements (No. 4239); and he was surprised to find it identical in every respect with four collections obtained by him several years ago in Virginia, Tennessee, and Pennsylvania. The description of *Clitocybe megalospora* corresponds to that of *Collybia radicata*, the lamellae being described as white or yellowish and the spores as hyaline and very large, reaching 17–18 × 10–12 μ. The plants collected by the author in Virginia and elsewhere were in each case determined when fresh as undoubtedly *Collybia radicata* and the accompanying field notes described them as sticky when moist, white, with yellowish center and white lamellae.

It was not until several years later, when these specimens were examined in the herbarium, that the lamellae were found to be brick-red and a microscopic mount from the lamellae apparently showed a mycelium bearing enlarged red tips rounded off at the apex, which seemed to become constricted and separate as spores. It is difficult to make a microscopic study of this kind from dried material, and further study was deferred with the hope that additional material might be found in the fresh state. The type of *C. megalospora* upon microscopic examination showed the same reddish bodies and the lamellae were partly colored red by them. It is possible that we have here an interesting microscopic organism which changes the color of the lamellae, but why this occurs after the specimen is collected and dried is not so clear. Many of the rosy-spored gill-fungi have whitish lamellae

when fresh, and these become rose-colored on drying from the mature rose-colored spores. It is hoped that collectors during the coming season will be on the lookout for plants of "*Collybia radicata*" that turn red on the under side in drying.

W. A. MURRILL.

THE TWENTIETH ANNIVERSARY OF THE NEW YORK BOTANICAL GARDEN

The twentieth anniversary of the appropriation by the City of New York of 250 acres of land in Bronx Park for the use of the New York Botanical Garden will be commemorated at the Garden during the week commencing September 6, 1915. Botanists from all parts of North America are invited to attend. The following program is planned; and other excursions, of more special character, may be arranged if opportunity offers.

Monday, September 6

10–1:30. Assemble at the Garden as convenient
1:30. Lunch at the Garden
2:30. Addresses of welcome and an account of the history of the Garden
3:30–5:30. Inspection of a portion of the grounds and buildings
5:30–7:00. Visit to Zoological Park

Tuesday, September 7

10:30–1:00. Session for the reading of papers
1:30. Lunch at the Garden
2:30–4:00. Session for the reading of papers
4:00–6:00. Inspection of portions of the buildings and grounds

Wednesday, September 8

Salt Water Day on Staten Island for a study of the coastal flora
Lunch at 1:30 with subsequent opportunity for scientific oratory

Thursday, September 9

10:30–1:00. Session for the reading of papers
1:30. Lunch at the Garden
2:30–4:00. Session for the reading of papers
4:00–6:00. Inspection of portions of the grounds and buildings

Friday, September 10

Visit to the pine barrens of New Jersey under the guidance of the Torrey Botanical Club

Saturday, September 11

Visit to the Brooklyn Botanic Garden and an excursion to some Long Island locality

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MYCOLOGIA

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ILLUSTRATIONS OF FUNGI—XXI

William A. Murrill

Figures 3 and 4 on the accompanying plate were drawn from specimens collected by the author at Stockbridge, Massachusetts, with the aid of Dr. W. Gilman Thompson. The other specimens used were collected in or near Bronx Park, New York City.

Panaeolus solidipes Peck

Solid-stemmed Panaeolus

Plate 160. Figure 1. × 1

Pileus firm, at first hemispheric, then subcampanulate or convex, 5–7 cm. broad; surface smooth, whitish, the cuticle at length breaking up into dingy-yellowish, rather large, angular scales; lamellae broad, slightly attached, whitish, becoming black; spores broadly ellipsoid, very black with a bluish tint, 17.5 × 10 μ; stipe firm, smooth, white, slightly striate at the apex, solid, 12–17.5 cm. long, 4–8 mm. thick.

This species, which is unusually large for the genus, occurs rarely in manure heaps or in heavily manured ground in the eastern United States. According to Peck's original description and figure, the surface becomes distinctly scaly with age. The specimens here figured, found in the New York Botanical Garden, were probably collected before this character had developed.

[Mycologia for May, 1915 (7: 115–162), was issued June 15, 1915.]

Lactaria plinthogala (Otto) Burl.

SOOTY LACTARIA

Plate 160. Figure 2. × 1

Pileus fleshy, convex to plane, sometimes with a small umbo, depressed in the center, then subinfundibuliform, 2–6.5 cm. broad; surface raw-umber to dingy-yellow-brown, snuff-brown, or putty-colored to pallid, usually darker in the center and at first, then fading, dry, glabrous but covered with a bloom, usually very smooth, sometimes wrinkled in the center when mature; margin entire or wavy; context white, changing to reddish or salmon where exposed to the air; latex white, tardily acrid, rarely changing color except when in contact with the broken flesh, where it becomes salmon-pink; lamellae nearly white at first, then maize-yellow, becoming pinkish or salmon where wounded, pruinose, sometimes forking near the stipe and sometimes connected with vein-like reticulations, subdistant, adnate or slightly decurrent, about 5 mm. broad; spores yellow, mostly globose, echinulate, 6.5–10 μ in diameter; stipe of the same color as the pileus, often whitish at the base, nearly equal or tapering downward, glabrous, pruinose, stuffed but firm, then hollow, 5–7 cm. long, 6–12 mm. thick.

This species is widely distributed in the eastern United States in deciduous or mixed woods. Certain closely related forms are sometimes difficult to distinguish, but they all appear to be regarded as edible.

Cortinellus decorus (Fries) P. Karst.

ORNAMENTED CORTINELLUS

Plate 160. Figure 3. × 1

Pileus thin, rather tough, convex becoming plane or slightly depressed, subexpanded, 4–7 cm. or more broad; surface moist, melleous, sometimes tinged with flavous, fuliginous at the center, dotted with minute, brownish or blackish, hairy squamules, margin incurved; context yellow, watery, mild, insipid, with unpleasant odor; lamellae adnate to slightly sinuate, crowded, arcuate, cremeous-flavous; spores subglobose, smooth, hyaline, 5–6 × 4–5 μ; stipe equal, often curved, stuffed or hollow, melleous, fibrillose or squamulose, especially above, rarely glabrous, sometimes eccentric, 2.5–6 cm. long, 4–6 mm. thick.

This pretty wood-loving species is not often seen, although it is widely distributed in temperate North America and Europe on decaying coniferous trunks. Peck's *Tricholoma multipunctum* is not distinct. The specimens here figured are unusually small.

Melanoleuca fumidella (Peck) Murrill

SOMEWHAT CLOUDED MELANOLEUCA

Plate 160. Figure 4. × 1

Pileus convex, then expanded, subumbonate, 2.5–5 cm. broad; surface smooth, moist, at times rimose-areolate, dingy-white or clay-color clouded with rose or brown, becoming paler when dried, the disk darker than the margin; context white, with distinctly farinaceous taste and odor; lamellae white, sinuate, broad, subventricose, not crowded; spores $4.5 \times 3.5\,\mu$; stipe equal, smooth, solid, splitting readily, whitish or pale-pinkish, 5–7.5 cm. long, 4–6 mm. thick.

This species is found rather frequently on the ground in woods from New England to North Carolina. The genus is exceedingly large and difficult.

Lactaria Volkertii sp. nov.

Plate 160. Figure 5. × 1

VOLKERT'S LACTARIA

Pileus hemispheric to convex, becoming rather deeply depressed at the center, solitary, reaching 7 cm. broad; surface dry, exactly fulvous, finely tomentose, the pellicle slightly separable toward the margin, which is somewhat concentrically zonate in mature plants; context very firm, white, mild in taste, with an odor suggestive of *Russula foetens*, but changing in drying; lamellae crowded, adnate, arcuate, some of them forked, showing no colored latex, but becoming brown when bruised as in species of *Lactaria* containing watery latex; spores globose to subglobose, rough, hyaline, 8–11 μ; stipe cylindric, equal, milk-white throughout, becoming brown when bruised, very solid and firm, reaching 5.5 cm. long and 2 cm. thick.

Type collected in moist ground in deciduous woods near Bronx Park, New York City, August 6, 1911, *W. A. Murrill & E. C. Volkert*. This beautiful species, which has been collected but once, has every mark of a *Lactaria* except the milky juice. The change

in color of the lamellae, however, is taken to indicate that the latex was scarce and watery. Miss Burlingham suggests that the dried specimens greatly resemble *L. lactiflua* in appearance and odor. I have never seen a specimen of *L. lactiflua* with the colors and surface characters of this plant nor without an abundance of latex in the younger stages. Miss Burlingham says that it does not resemble any species of *Russula*.

Ceriomyces retipes (Berk. & Curt.) Murrill

NETTED-STEMMED CERIOMYCES

Plate 160. Figure 7. × 1

Pileus convex above, concave or plane beneath, rarely cespitose, 5–12 cm. broad, 1–2 cm. thick; surface dry, opaque, somewhat viscid when wet, minutely tomentose to glabrous, sometimes covered with a yellow pulverulence, varying in color from yellow or yellowish-brown to fuliginous; context firm, light- to deep-yellow, unchanging, mild or slightly bitter; tubes adnate, slightly decurrent, somewhat depressed with age, 1 cm. or more long, clear lemon-yellow when young, becoming dull-yellow at maturity, darker with age, but not changing when wounded, mouths circular to angular, less than 1 mm. broad, slightly flesh-colored when bruised; spores oblong, smooth, yellowish-brown, 11–14 × 3–4.5 μ; stipe subequal, often bulbous at the base, distinctly and beautifullly reticulate, sometimes entirely to the base, yellowish-pulverulent in some specimens, yellow and firm within, yellow or yellowish-brown without, 5–12 cm. long, 0.5–2 cm. thick.

An attractive and well-marked edible species occurring commonly in thin woods from Nova Scotia to Alabama and west to Wisconsin. The cap varies in color from yellow to brown, the flesh and tubes are yellow, and the yellow stem is beautifully reticulated to the base. It was first described by Berkeley from plants collected by Curtis in North Carolina, and later Peck assigned the name *B. ornatipes* to a dark form of the same plant. Pecks' *B. griseus* is closely related but is gray with white tubes.

Scleroderma

SPECKLED PUFFBALL

Plate 160. Figure 8. × 1

This pretty little puffball is not uncommon in the eastern United States on the ground in thickets and open woods. It differs from the common hard-skinned puffball externally in being much smaller and paler in color and having a much thinner, flexible peridium. It has been called *Scleroderma tenerum* by some, but whether *S. tenerum* Berk. & Curt. described from Cuba is meant or not, I do not know.

Russula pectinatoides Peck

SLIGHTLY PECTINATE RUSSULA

Plate 160. Figure 9. × 1

Pileus thin, broadly convex, becoming nearly plane or centrally depressed, 2.5–7.5 cm. broad; surface chamois-colored to dingy-straw-colored or yellowish-brown to cinnamon-brown, darker in the center, viscid when moist, glabrous; margin widely tuberculate-striate; context grayish-white under the separable pellicle, otherwise white, mild or slightly and tardily acrid; lamellae white, becoming creamy, fulvous where bruised, mostly equal, some forking next to the stipe, adnate, thin; spores whitish, subglobose, 6–8 μ in diameter; stipe white, discoloring yellowish-brown where bruised or in drying, glabrous, spongy within, 2.5–5 cm. long, 5–10 mm. thick.

This species occurs in grassy ground in groves and woods from New England to Michigan and southward as far as North Carolina. The specimens figured represent the minimum size.

NEW YORK BOTANICAL GARDEN.

UREDINALES OF PORTO RICO BASED ON COLLECTIONS BY F. L. STEVENS

J. C. Arthur

The material illustrating the rust flora of Porto Rico, which was collected by Dr. F. L. Stevens and placed in my hands for study, represents a specially valuable contribution to the knowledge of tropical fungi. There were 650 numbers of the material submitted, which were mostly collected during the year 1913, only some twenty-three having been secured during the year 1912 and seven during January, 1914.

This is an especially notable achievement, as all other collections of rusts from the island taken together only slightly exceed 100. These range mostly through the last sixteen years. Among the previous collectors the two having the greatest knowledge of the *Uredinales* are Prof. E. W. D. Holway, leading with 25 collections made in January and February, 1911, and Dr. G. P. Clinton, following with 21 collections made in April, 1904. Some rusts have been included in collections made during the last few years by the botanists at the Experiment Station of the Porto Rico Sugar Growers' Association, about twenty-five of which have come to my attention.

Until the Stevens' material was available the general impression of the rust flora of Porto Rico has been that it was scanty and lacking in interest. Professor Holway, who is famous as a collector of microfungi, wrote from San Juan on January 29, 1911: "I have just come in from our trip across and around the island; rusts are very scarce." Again in a letter from Minneapolis, Minn., dated March 21, 1911, he writes: "I am just home from Porto Rico; I will send you the specimens soon. There are not many, but more than Sintenis got in his three years there." It now appears from the work of Dr. Stevens, however, that there are plenty of species in the island and some of exceptional interest, although the rust flora is not generally as conspicuous as is usual in temperate regions.

The 650 collections distribute themselves under 109 species of rusts, giving an average of about 6 collections to each species. Actual duplicates in the set are few, however. The several numbers under each species are often required for additional hosts, over 170 species altogether being represented, many not heretofore recorded as such, for illustrating successive stages of the fungus, some before unknown, and for distribution, over 65 localities having been visited.

The species previously known from Porto Rico do not exceed thirty-five in number, or about one third of the number secured by Dr. Stevens. The richness of Dr. Stevens' set is also attested by showing thirty-nine species, or over one third of his collection, as additions to the previously known rust flora of North America, of which number eighteen are new to science.

The family *Coleosporiaceae* is represented in Porto Rico by three species, of which *Coleosporium Plumierae* is distinctly West Indian. It is not, however, certain that this species is entirely autonomous, it may well be only a race of some earlier described species of wide range. Only cultures will fully elucidate this point. It is significant that no member of the genus *Pinus* occurs in Porto Rico. So far as known the species of *Coleosporium* form their aecia only on leaves of pines. It is practically certain that the three species in Porto Rico maintain themselves by the uredinial repeating spores, and are not indigenous to the island.

The family *Uredinaceae,* often called *Melampsoraceae,* is somewhat better represented. Five species are listed here. Two of these (under *Kuehneola*) have heretofore been invariably placed with the next family. The shift is made on account of the catenulate teliospores, in contradistinction to simple teliospores with one or more cells, and the resemblance of the uredinial sorus to that of *Pucciniastrum* in the manner of spore formation. The species of the family are like those of the preceding family in maintaining themselves by the uredinial repeating spores, only one, *Cerotelium Canavaliae,* being known to produce telia in the West Indies, and for none of them is the aecial condition known. There are five other forms listed under the form-genus

Uredo, which doubtless belong in this family. One of these forms, *Uredo fenestrala,* possesses a peridium having elongated cells at the sides and isiodiametric cells above, as in the genera *Schroeteriaster* and *Hyalopsora.* The other four forms, Nos. 105, 106, 107 and 108, have a pseudoperidium formed of imbricated paraphyses, which indicates a position near *Kuehneola* and *Physopella.* Possibly the fern rust, *Uredo Gymnogrammes,* also belongs near these forms. If all these were to be counted in, we would have eleven species under the family *Uredinaceae.*

The family *Aecidiaceae* (*Pucciniaceae*) contains the chief part of the Porto Rican rusts. There are sixty-three species so assigned in the following enumeration, of which one, *Pucciniosira pallidula,* is usually placed under the *Uredinaceae,* but is here shifted to the *Aecidiaceae* on account of the structure of the sorus. To these sixty-three should be added the species under the form-genus *Aecidium,* and such of those under *Uredo* as have not just been assigned to the other families, or eighty-five species in all. It is probable, however, that some of the species under the two form-genera merely represent stages of species already named under *Uromyces* or *Puccinia.* It almost amounts to a certainty that the ten species of *Aecidium* represent aecial forms to be distributed among the fifteen grass and sedge rusts enumerated, or those yet to be found. It is doubtless safe to assume, that omitting the names eventually to be reduced to synonymy, we ought to have remaining from this list about seventy-five species under the family *Aecidiaceae.*

The collection made by Dr. Stevens proved so representative of the Porto Rican rust flora in particular and of the West Indian in general that it has required little additional space to mention all other collections from the region known to the writer. No careful attempt has been made to secure all references made in literature, where the material was not available for examination. It is believed, however, that the presentation here made is a fairly exhaustive record of the West Indian *Uredinales.* After the enumeration of species in the Stevens collection, a list of twelve species is given, which embraces all material from Porto Rico secured by other collectors, so far as the writer knows, that

was not represented in the Stevens collection. We may say, therefore, that the present known rust flora of Porto Rico numbers 121 species or, eliminating possible duplication (ten species of *Aecidium*), 111 species.

From all the other West Indian islands (excluding Trinidad) an additional nineteen species have come to light, which are given in a separate list. This makes 140 species of rusts for the West Indies, or by omitting undistributed aecia 130 species. Doubtless a few species already recorded have been overlooked. Unquestionably many species yet await the collector.

The writer desires to express his appreciation of Dr. Stevens' courtesy in supplying his material so unreservedly for study, and for information of various kinds regarding the island flora. He also wishes to extend thanks to the staff of the New York Botanical Garden, and to Prof. A. S. Hitchcock, Agrostologist of the U. S. Department of Agriculture, and to others who have assisted in the determination of the hosts. Especial recognition is due Mr. Percy Wilson of the N. Y. Bot. Garden for the unlimited patience and ready acumen, which he brought to bear in working over the great number of fragmentary specimens, and searching out corroborative or illustrative material from the phanerogamic herbarium, in order to determine the hosts with certainty and to extend knowledge of the range of the rusts.

FAMILY: **Coleosporiaceae**

1. COLEOSPORIUM ELEPHANTOPODIS (Schw.) Thüm. Myc. Univ. *953*. 1878.

ON CARDUACEAE:

Elephantopus mollis H.B.K., Maricao, Jan. 10,* *201*, Jan. 15, *287*, April 3, *869*; Corozal, Feb. 21, *411*; Yauco, Oct. 3, *3154*, *3248*; Jajome Alto, Dec. 3, *5638*; Jayuya, Dec. 17, *5997*; Mayagüez, Dec. 25, *6294*; River junction below Utuado, Dec. 30, *6600a*; St. Ana, Dec. 31, *6623*; Preston's ranch near Naguabo, Dec. 31, *6682*; without locality or date, *513*.

* All dates in citation of the Stevens Porto Rican material are to be considered in the year 1913, unless otherwise stated.

The species has also been collected on *E. mollis* at Mayagüez, by A. A. Heller, Feb. 9, 1900, II & III, *4569*, at Bayamon, by E. W. D. Holway, Jan., 1911, and at Rio Piedras, by Johnston & Seaver, Dec., 1913, II, *1108*. It was a portion of the Heller collection that is the basis of the entry in N. Am. Flora, vol. 7, p. 90, under *Elephantopus scaber,* a species not represented in the American flora, but belonging to the Eastern Hemisphere, although both North and South American collections have been reported under that name.

Material has also been examined on *E. mollis* from Cuba and Jamaica, and on *E. angustifolius* Sw. from St. Vincent.

2. COLEOSPORIUM IPOMOEAE (Schw.) Burr. Bull. Ill. Lab. Nat. Hist. **2**: 217. 1885.

ON CONVOLVULACEAE:

Ipomoea Batatis Lam., Preston's ranch near Naguabo, Dec. 31, II, *6668*.

Ipomoea Nil Roth, Guayanilla, Nov. 13, II, *5898*.

Jacquemontia tamnifolia (L.) Griseb., Rio Piedras, Nov. 10, II, *5728*.

Material has also been examined on *Ipomoea littoralis* Blume, from San Juan, Jan., 1911, II, E. W. D. Holway, on *I. stolonifer* (Cyrill) Poir., from Vieques Island, Jan., 1914, II, J. A. Shafer *2406*, on *Quamoclit coccinea* (L.) Moench, Vieques Island, Jan., 1914, II, J. A. Shafer.

Collections have been seen on *I. Nil* and *Q. coccinea,* from St. Croix, and on *J. tamnifolia,* from Cuba.

3. COLEOSPORIUM PLUMIERAE Pat. Bull. Soc. Myc. Fr. **18**: 178. 1902.

ON APOCYNACEAE:

Plumiera Krugii Urban, Maricao, Jan. 10, II, *290*, Oct. 20, 1912, II, *28c*; Monte Alegrillo, Nov. 14, II, *4525*.

Plumiera obtusa L., Mona Island, Dec. 20, 21, II, *6101*.

The two hosts have not before been reported for North America. A specimen on *P. obtusa* has been received from Mel. T. Cook, collected at Santiago de las Vegas, Cuba, June, 1906.

The species was previously known on *P. alba* L. from Guadeloupe, and on *P. rubra* L., from Cuba.

FAMILY: **Uredinaceae (Melampsoraceae)**

4. PHYSOPELLA VITIS (Thüm.) Arth. Result Sci. Congr. Bot. Vienne 338. 1906.

Uredo Vitis Thüm. Pilze Weinst. 182. 1878.

Uredo Vialae Lagerh. Compt. Rend. Acad. Sci. Paris **110**: 729. 1890.

Phakopsora Vitis Sydow, Hedwigia Beibl. 38: 141. 1899.

ON VITACEAE:

Vitis vinifera L., Pastillo Springs, Nov. 10, *5718*; Mayagüez, Dec. 26, *6304*, Jan. 5, 1914, *6731*.

Until full life history is known any generic assignment of species must generally remain somewhat doubtful. The only question involved in making the record in the present instance is whether or not this species, which was the type of the genus *Physopella,* differs sufficiently in important characters to keep it out of the earlier genus *Phakopsora,* to which it is assigned in Sydow's Monog. Uredinearum (3: 410. 1914). *Phakopsora* has a similar telial sorus, but the uredinial sorus, according to Magnus, Sydow, and others, for the writer has not seen suitable material, possesses a peridium opening by a central pore, whereas in the species on *Vitis* the uredinial sorus possesses peripheral free paraphyses. In no genus well established by species of fully known life histories is such an association of characters known. The species on *Vitis* is, therefore, listed under *Physopella,* rather than under *Phakopsora,* as better representing present knowledge of distinctions, while at the same time disavowing assumption of relationships. This limitation of the generic character of *Physopella,* taken in connection with other information brought to light since the establishment of *Physopella* as a genus in 1906, throws out all species that are listed under the genus in the N. Am. Flora, except the type.

So far the species in the West Indies has only been found on the cultivated grape, and only in the uredinial stage. It has been collected near Kingston, Jamaica, by G. von Lagerheim in

1889, by T. D. A. Cockerell in 1892, and by F. S. Earle in 1902. A collection was made at Havana, Cuba, by E. W. D. Holway in 1903.

5. KUEHNEOLA FICI (Cast.) Butler, Ann. Myc. 12: 76. 1914.
Uredo Fici Cast.; Desmaz. Pl. Crypt. *1662*. 1848.
Uredo ficicola Speg. Anal. Soc. Ci. Argent. 17: 120. 1884.
Uredo ficina Juel, Bih. K. Sv. Vet.-Akad. Handl. 23(3)[10]: 25. 1897.
Uredo moricola P. Henn. Hedwigia 41: 140. 1902.
Physopella ficina Arth. N. Am. Flora 7: 103. 1907.
Physopella Fici Arth. N. Am. Flora 7: 103. 1907.

ON ARTOCARPACEAE:

Ficus laevigata Vahl, Santurce, Jan. *22*, *257* (Barth. N. Am. Ured. *920*); Vega Baja, Feb. 20, *461*, May 18, *2044*, Dec. 31, *6621*, Mona Island, Dec. 20, 21, *6078*, *6179*, *6423*; Cabo Rojo, Dec. 27, *6461*; River junction below Adjuntas, Dec. 30, *6614*.

Ficus sp. indet., Jayuya, March 1, *426*.

This species was also collected on *Ficus Carica* L., at San Juan, Porto Rico, May, 1903, F. S. Earle, *33*.

Although this rust is doubtless common wherever figs are grown, yet the only other collections that are represented in the Arthur Herbarium from the West Indies are from Santiago de las Vegas, Cuba, on *F. Carica*, by W. T. Horne, March 13, 1906, and by Mel. T. Cook, July 21, 1906.

Until recently no teliospores of this species have been known. They were found in India by E. J. Butler (l. c.) on *Ficus glomerata*. Mr. Butler has given a good description of the fungus, with a figure showing germination of the teliospores. The assignment of the species to *Kuehneola* seems the best disposition of it that can be made at present. It should be borne in mind, however, that the position of the species remains doubtful so long as the full life history is not known. It may be assumed that pycnia and primary uredo may occur in a region where teliospores are produced, but when teliospores are absent and the reproduction is by secondary uredo there is no possibility of pycnia occurring.

The two species of *Ficus* rust described in N. Am. Flora (**7**: 103. 1907) are here united. It was found in carefully studying the ample collections by Dr. Stevens that they showed great variation in size of spores and development of paraphyses. Upon comparing data from all sources available there remained no doubt that only one species is represented, whether paraphyses with thick or thin walls are present in full development or practically absent, or whether the spores are larger or smaller, etc.

The genus *Kuehneola* is here associated with *Physopella, Phakopsora, Pucciniastrum,* etc., in the *Uredinaceae,* instead of with *Phragmidium* in the *Aecidiaceae,* as heretofore. The change is made on account of the evident unpedicelled, catenulate teliospores, corresponding to those of *Melampsoropsis* and other genera of the former family, but clearly alien to the *Aecidiaceae.*

6. KUEHNEOLA GOSSYPII (Lagerh.) Arth. N. Am. Flora **7**: 187. 1912.

Aecidium desmium Berk. & Br. Jour. Linn. Soc. **14**: 95. 1873.
Uredo Gossypii Lagerh. Jour. Myc. **7**: 48. 1891.

ON MALVACEAE:

Gossypium barbadense L., Isabela, Nov. 22, *5226*; Mona Island, Dec. 20, 21, *6141*.

Gossypium brasiliense Macf., River junction below Utuado, Dec. 7, *6052*.

The rust was found on *G. hirsutum* L. at Mayagüez, P. R., May, 1903, by F. S. Earle, *78*.

The only other specimen in the Arthur Herbarium from the West Indies is one collected on a species of tree cotton at Santiago de las Vegas, Cuba, Aug., 1904, by C. F. Baker (Barth. Fungi Columb. *2489*), although the rust is doubtless rather common in the warm regions adapted to cotton growing.

7. **Milesia columbiensis** (Dietel) comb. nov.

Milesina columbiensis Dietel; Mayor, Mem. Soc. Neuch. Sci. **5**: 559. 1913.

ON POLYPODIACEAE:

Nephrolepis rivularis (Vahl) Urban, without locality, Nov., *4504*; Agucaltaria, Nov. 25, *4855*.

The collections here listed were the first North American representatives of the genus seen by the writer, but they were followed almost immediately by a collection of **Milesia Kriegeriana** (Magn.) comb. nov. (*Milesina Kriegeriana* Magn.) on *Aspidium marginale,* from Hudson, Quebec, Canada, communicated by W. P. Fraser, who made the collection in June, 1913.

Up to the present time the only other North American collection known to the writer, that should be placed in the genus, was found on a specimen of *Dryopteris patens* (Sw.) Kuntze in the fern collection of the N. Y. Bot. Garden, obtained at Whitfield Hall, Jamaica, 3,000 feet altitude, April 20, 1903, L. M. Underwood *2522*. The species appears to be similar to *M. Kriegeriana,* but sufficiently distinct to merit a separate name. It may be called **Milesia consimilis** sp. nov., and characterized by the ellipsoid or obovoid urediniospores, being 16–21 by 26–29 μ, with colorless wall, 2.5–3.5 μ thick, moderately to sparsely echinulate with rather large points. The peridium is similar to that in *M. Kriegeriana.*

I am using the genus name *Milesia,* as I believe it was properly established upon the most distinctive spore form that could have been selected (Cf. Science **40**: 935. 1914), and that the rechristening by Magnus (Ber. Deut. Bot. Ges. **27**: 325. 1909) was superfluous, although conforming to the ruling of the Brussels Congress.

8. CEROTELIUM CANAVALIAE Arth. Bull. Torrey Club **33**: 30. 1906.

ON FABACEAE:

Canavalia ensiformis DC., Mayagüez, May 4, II, *1833*; Manati, Nov. 5, II, *4321*.

The species has heretofore only been known from the type collection, which was made at Mayagüez, P. R., April 16, 1904, by G. P. Clinton.

FAMILY: **Aecidiaceae (Pucciniaceae)**

9. RAVENELIA CAULICOLA Arth. N. Am. Flora **7**: 143. 1907.

ON FABACEAE:

Cracca cinerea (L.) Morong, Desecheo, May 31, II, *1621*; Quebradillas, Nov. 22, II, *5016*.

Only two other collections of this West Indian rust are known to the writer. One was found at Cataño, P. R., Feb. 14, 1914, by Johnston & Seaver, *1370*, and the other is the type collection, which was taken from a phanerogamic specimen in the Field Museum, Chicago, obtained by Britton & Millspaugh at Cave Cay, Bahamas, Feb. 19, 1905. Both collections are on *Cracca cinerea*.

10. RAVENELIA INDIGOFERAE Tranz. Hedwigia 33: 369. 1894.

ON FABACEAE:

Indigofera suffruticosa Mill. (*I. Anil* L.), Boqueron, Feb. 15, II, *340*, II, *355*; Bayamon, Feb. 16, II, *399*; Jayuya, March 31, *692*; Mayagüez, Aug. 13, II, *3021*; Aguada, Nov. 22, *5106*.

It was also collected on the same host at Cataño, P. R., Feb. 14, 1914, by J. R. Johnston *1368*.

The other West Indian islands represented in the Arthur Herbarium are Bermuda, by W. G. Farlow, Jan., 1881; Cuba by W. T. Horne, March 15, 1905, and April 5, 1906, by C. F. Baker, Jan. 15, 1907 (Barth. Fungi Columb. *2475*), all three from Santiago de las Vegas; and Jamaica, by F. S. Earle, *33*, E. W. D. Holway, Feb. 17, 1915, *215*, all the collections being on *I. suffruticosa*.

11. RAVENELIA INGAE (P. Henn.) Arth. N. Am. Flora 7: 132. 1907.

ON MIMOSACEAE:

Inga vera Willd., Monte Montosa, Oct. 13, 1912, *976*, Oct. 14, 1912, *28d*; Monte Alegrillo, June 20, *2376*.

The fungus on the same host has also been collected in Porto Rico at Ponce, O. W. Barrett, Aug., 1904. No other West Indian collections are known to the writer.

On some of the leaves the fungus forms loose brown masses, consisting mostly of spores, that have the appearance of insect ejecta. The resemblance is aided by the leaf being puffed and broken at these places, the spots often being a centimeter across.

12. **Ravenelia Stevensii** sp. nov.

Pycnia not seen.

Uredinia hypophyllous, numerous, scattered, round, small, 0.1–0.3 mm. across, subcuticular, early naked, dull cinnamon-brown, ruptured cuticle inconspicuous; paraphyses in a thick peripheral ring, upright, capitate to clavate, 9–12 by 37–45 μ, smooth, wall of head 2–5 μ, cinnamon-brown, passing into the thin-walled, colorless stipe; urediniospores oblong, cylindric-oblong, or narrowly obovoid, 8–13 by 25–30 μ; wall cinnamon-brown, paler below, uniformly thin, less than 1 μ, slightly thicker above, very finely and inconspicuously verrucose-echinulate, the pores usually indistinct, about 4, equatorial.

Telia hypophyllous, few, very small, subcuticular, blackish-brown; teliospore-heads chestnut-brown, 3–6 cells across, 40–63 μ across, each spore bearing 1–3 nearly hyaline tubercles, 2–3 μ thick, 6–19 μ long, 2–3 forked above; cysts hyaline, globoid, extending from periphery to pedicel, not bursting in water; pedicel hyaline, short, usually wanting.

ON MIMOSACEAE:

Acacia riparia H.B.K., Guayanilla, Nov. 13, II, III, *5881* (type); Vega Baja, Feb. 22, II, *366*, May 18, II, *2047*; Peñuelas, Nov. 8, II, *4895*.

This very distinctive species of *Ravenelia* is dedicated to Dr. F. L. Stevens, who has not only made all the collections of it so far known, but has supplied a wealth of material representing Porto Rican Uredinales far exceeding that of all previous collectors, as the present paper amply testifies.

13. PROSPODIUM APPENDICULATUM (Wint.) Arth. Jour. Myc. 13: 31. 1907.

Puccinia appendiculata Wint. Flora 67: 262. 1884.

ON BIGNONIACEAE:

Stenolobium Stans (L.) D. Don. (*Tecoma Stans* Juss.), Hormigueros, June 23, II, *2494*.

The other West Indian collections seen by the writer are by E. W. D. Holway in Cuba at Holquin and at Havana, 1903, by Dr. Stevens in Martinique, Aug. 4, 1913, *2974*, all three on *S. Stans* and all showing uredinia only, and one by Holway in Jamaica, on *S. Stans,* Feb., 1915, *222*, showing II & III.

14. **Argomyces insulanus** sp. nov.

Pycnia epiphyllous, subepidermal, few in crowded groups, globoid-flask-shaped, 105–175 by 170–200 μ.

Aecia uredinoid (primary uredo), hypophyllous, few surrounding the pycnia, sometimes confluent; aeciospores somewhat larger than the urediniospores. Otherwise same as the uredinia.

Uredinia hypophyllous, few, scattered, round or oblong, small, 0.3–0.5 mm. long, early naked, pulverulent, dull cinnamon-brown, ruptured epidermis evident; urediniospores ellipsoid or obovoid, 19–26 by 26–35 μ; wall cinnamon-brown, moderately echinulate, 1.5–2.5 μ thick, the pores usually three, equatorial or slightly subequatorial, indistinct.

Telia hypophyllous, few, usually scattered, round to oblong, 0.3–0.8 mm. long, early naked, dull cinnamon-brown, germinating at maturity, ruptured epidermis evident; teliospores broadly ellipsoid to ellipsoid-fusiform, 19–30 by 42–60 μ, obtuse, or somewhat attenuated at both ends, slightly constricted at septum; wall pale cinnamon-brown, thin, 1–1.5 μ, with a low hyaline papilla over the pore, disappearing at germination, smooth, the pore in lower cell near the septum; pedicel slender, colorless, once length of spore or less.

ON CARDUACEAE:

Vernonia albicaulis Pers., River junction below Utuado, Dec. 30, O, II, III, *6596* (type), O, II, III, *6589*.

Vernonia longifolia Pers., Villa Alba, Jan. 3, III, *113*.

This species differs from *Arg. Vernoniae* by the broad and much larger teliospores. It is notably distinct from *Puccinia Becki* Mayor and *P. Vernoniae-mollis* Mayor, both from Colombia, S. A., the former having very long, slender teliospores, and the latter very small teliospores.

Arg. insulanus also occurs on the island of St. Croix. It was collected by A. E. Ricksecker in 1896, and recorded by Ellis & Kelsey (Bull. Torrey Club 24: 208. 1897), under the name of *Puccinia Vernoniae* Cooke. The determination was considered doubtful at the time. Although the type of *P. Vernoniae,* which is African, has not been seen, yet there is slight chance of the West Indian and African forms being the same. Another representative of the St. Croix rust has been communicated by Mr. Percy Wilson, who found it on a phanerogamic specimen collected in St. Croix, Jan. 17, 1896, on *V. albicaulis,* by Marion

Hoy *220*. The host species of the Ricksecker collection is clearly identical with the Hoy collection.

15. ARGOMYCES VERNONIAE Arth. N. Am. Flora 7: 218. 1912.

ON CARDUACEAE:

Vernonia borinquensis Urban, Consumo, April 27, O. II. III, *809*; Jajome Alto, Dec. 3, O, II, III, *5684*; El Gigante near Adjuntas, Dec. 15, II, III, *5962*.

Vernonia phyllostachya (Cass) Gleason, Cabo Rojo, Dec. 27, II, III, *6473*.

The species was described from a Porto Rican collection from Cayey, on *V. borinquensis*, by E. W. D. Holway, Jan., 1911. The Stevens collections are the first additions to the type material so far seen. The shape and the pore arrangement as given for the urediniospores in the original description appear to need some modification. The spores may be ellipsoid, and the pores more than four and not strictly equatorial.

16. UROMYCES ERAGROSTIDIS Tracy, Jour. Myc. 7: 281. 1893.

Nigredo Eragrostidis Arth. Result. Sci. Congr. Bot. Vienne 343. 1906.

ON POACEAE:

Eragrostis tephrosanthus Schult., Bayamon, Feb. 21, II, *442*.

The species was collected on the same host by Mr. & Mrs. A. A. Heller at Rio Piedras, Jan. 17, 1899, *197*, which is the only other West Indian collection known to the writer.

17. UROMYCES LEPTODERMUS Sydow; Sydow & Butler, Ann. Myc. 4: 430. 1906.

Puccinia (?) *panicicola* Arth. Bull. Torrey Club 34: 586. 1908.

Nigredo leptoderma Arth. N. Am. Flora 7: 224. 1912.

ON POACEAE:

Lasiacis divaricata (L.) Hitchc. (*Panicum divaricatum* L.), Coleña, Nov. 3, *4528*; Utuado, Nov. 8, *4608*; San German, Dec. 8, *4677*, Dec. 12, *5857*; Maricao, Nov. 18, *4793*; Mona Island, Dec. 20, 21, *6089*, *6145*, *6425*.

Lasiacis Sloanei (Griseb.) A. S. Hitch. (*Panicum Sloanei* Griseb.), Arecibo, Jan. 17, 1914, *6805*.

Panicum barbinode Trin. (*P. molle* Auct. not Swartz), Guanica, Feb. 1, *350*; Boqueron, Feb. 15, *350 bis;* Mayagüez, March 26, *447*, March 9, *480*; Peñuelas, Nov. 8, *4560*.

Only one of these collections, *6145* from Mona Island, shows teliospores, and that only sparingly so.

A collection determined by Prof. Hitchcock to be on *Lasiacis Swartziana* Hitchc. (*Panicum lanatum* Sw. not Rottb.) was collected by R. Thaxter, 1891, in Jamaica, and communicated by W. G. Farlow, which shows both uredinia and telia. Material representing the species has also been collected at Santiago de las Vegas, Cuba, on *P. barbinode* and thought at first to show only uredinia, but on which a few telia have recently been detected. *L. Sloanei* is a host for the species not before reported.

18. **Uromyces ignobilis** (Sydow) comb. nov.

Uredo ignobilis Sydow, Ann. Myc. **4**: 444. 1906.

Uromyces major Arth. Bull. Torrey Club **38**: 377. 1911.

Nigredo major Arth. N. Am. Flora **7**: 225. 1912.

ON POACEAE:

Sporobolus indicus (L.) R. Br., Mayagüez, II, April 30, *925*.

The Stevens material agrees exactly with the description of *Uredo ignobilis* Sydow, the type being on *Sporobolus diandrus* from Pusa, India, and with the collection by E. J. Butler from the type locality, distributed in Sydow, Uredineen *2199*. The spores of the Porto Rican material also agree with the four-pored, thick-walled urediniospores of *Uromyces major,* the type of which is on some species of *Muhlenbergia* from the vicinity of the City of Mexico. The genera *Sporobolus* and *Muhlenbergia* are only technically different, so that it is not surprising to find the same tropical rust on hosts belonging to both genera, and from very widely separated localities. The three stations mentioned are the only ones yet known for the species.

19. UROMYCES RHYNCOSPORAE Ellis, Jour. Myc. 7: 274. 1893.

Nigredo Rhyncosporae Arth. Result. Sci. Congr. Bot. Vienne 344. 1906.

ON CYPERACEAE:

Rynchospora micrantha Vahl, Preston's ranch near Naguabo, Dec. 31, *6766*.

Porto Rican material on the same host has been seen from Tabucoa, taken from a phanerogamic collection by Boeckeler *5301*, Oct. 12, 1886, and on *R. aurea* Vahl, collected by G. P. Clinton, at Mayagüez, April 13, 1904.

Collections have also been examined on *R. cyperoides* (Sw.) Mart. from Bahamas, on *R. distans* (Michx.) Vahl, from Cuba and Bermuda, and on *R. polyphylla* Vahl, from Jamaica, all of which are noted in the N. Am. Flora, vol. 7, pp. 232, 233.

20. UROMYCES SCLERIAE P. Henn. Hedwigia Beibl. 38: 67. 1899.

Nigredo Scleriae Arth. Result. Sci. Congr. Bot. Vienne 344. 1906.

ON CYPERACEAE:

Scleria pterota Presl. Luguillo forest, Dec. 2, *5552*.

Material has also been seen on the same host from Bayamon, E. W. D. Holway, Jan., 1911, and on an undetermined species of *Scleria* from near Santurce, A. A. Heller, Jan., 1903, *6447*.

21. UROMYCES COMMELINAE (Speg.) Cooke, Trans. Roy, Soc. Edinb. 31: 342. 1888.

Uredo Commelinae Speg. Anal. Soc. Ci. Argent. 9: 172. 1880.

Uredo Commelinaceae Ellis & Kelsey, Bull. Torrey Club 24: 209. 1897.

Nigredo Commelinae Arth. N. Am. Flora 7: 237. 1912.

ON COMMELINACEAE:

Commelina virginica L. (*C. elegans* H.B.K.), Desecheo, May 31, *1578c*.

The only other West Indian collection seen is on the same host from St. Croix, made in 1896 by A. E. Ricksecker, which was used as the type for Ellis & Kelsey's name.

In Mayor's work on the Colombian rusts this species is recorded from Jamaica on *Commelina nudiflora* and *Tradescantia multiflora.* It is doubtless a common rust throughout the tropical world, but too inconspicuous to be often collected.

The single collection of this species by Stevens shows only uredinia, as has been the case with most other collections. The type collection for Cooke's name, which has been examined through the kindness of the Director of the Kew Gardens, shows both telia and uredinia. This collection came from Socotra, an island at the mouth of the Gulf of Aden. Other collections with both telia and uredinia have been examined from the eastern border of Africa along the coast of the Red Sea, and also a collection from the Malabar Coast of western India. No telia are known on any collection from the western hemisphere; and no pycnia or aecia from any part of the world have been associated with the species. It was placed in *Nigredo* on the assumption that the morphological and host characters warranted the belief in pycnia and aecia of a certain form to complete the life cycle.

22. **Uromyces Caesalpiniae** (Arth.) comb. nov.

Ravenelia Caesalpiniae Arth. Bull. Torrey Club 31: 5. 1904.

ON MIMOSACEAE:

Mimosa ceratonia L., Bayamon, Feb. 19, O, II, III, *393*, March 2, *508 bis*, May 21, *1868*; Vega Baja, March 2, *508*, May 21, *1929*, Nov. 5, *4264*; Monte Alegrillo, June 20, *2335*; St. Catalina, Aug. 28, *2723*; Cabo Rajo, July 28, *3163*; Indiera Fria, Maricao, *3454*; Abonita, Nov. 3, *4020*; Vega Alta, November, *4153*; San Sebastian, Nov. 22, *4510*; Lares, Nov. 22, *4850*; Manati, *5306*; Luguillo forest, Dec. 2, *5432*; San German, Dec. 8, *5764*; El Gigante near Adjuntas, Dec. 15, *5970*; Preston's ranch near Naguabo, Dec. 31, *6657*.

The type material of *Ravenelia Caesalpiniae* Arth., now in the Arthur Herbarium, was scanty, consisting of two compound leaves, bearing together twelve leaflets, moderately supplied with pycnia and uredinia, but no telia. The collection was made near Bayamon, P. R., in 1901, by L. M. Underwood and R. F. Griggs,

both excellent botanists. It was labeled by the collectors as "on *Caesalpinia*." As the pycnia and uredinia closely simulate those of various species of *Ravenelia*, the material was named accordingly.

No other collections were brought to light until those by Dr. Stevens arrived, the earliest being from Bayamon, gathered Feb. 19 and March 2, 1913. This material showed telia, as well as pycnia and uredinia, and consisted of numerous leaves accompanied by pods. It was submitted to the New York Botanical Garden for determination of the host. In the meantime Dr. N. L. Britton examined the host in the field for Dr. Stevens and pronounced it to be *Mimosa ceratonia*, most probably, and this determination was repeatedly and independently confirmed at the New York herbarium by Mr. Percy Wilson.

Now that the full life-cycle of the species is known, it proves to be a most difficult one to place. If we consider the structure and formation of all three kinds of sori, the peculiar urediniospores with their paraphyses, and the host relationship, the rust is preponderatingly like a *Ravenelia*, but the teliospores are borne singly and simulate a *Uromyces*. With present knowledge there seems no better way to do than enter the species under *Uromyces*. Technically it would fall under *Klebahnia*. The specific name is an unfortunate one, but we hesitate to add another to synonymy. Description of the telia is here appended.

Pycnia and uredinia as given in N. Am. Flora 7: 141. 1907. Telia amphigenous, similar in size and appearance to the uredinia except much darker in color, chocolate-brown, subcuticular, ruptured epidermis noticeable; paraphyses wanting; teliospores obovoid, 15–20 by 24–34 μ, usually narrowed below, rounded or obtuse above, often with a hyaline papilla over the germ-pore; wall chocolate-brown above, much paler below, thin at the sides, 1 μ, thickened at apex, 3–5 μ, smooth; pedicel somewhat tinted, half length of spore or shorter, thick, 5–7 μ.

23. UROMYCES JAMAICENSIS Vesterg. Ark. Bot. Stockh. 4^{15}: 33. 1905.

ON CASSIACEAE (CAESALPINIACEAE):

Bauhinia pauletia Pers., San German, Jan. 19, *238*, Nov. 8, *5786*, Dec. 12, *5866*; Mayagüez, Oct. 31, *3924*.

A collection on the same species of host was also made at Mayagüez, January, 1911, by E. W. D. Holway.

The type of the species came from Jamaica, as the name indicates, and is on an undetermined species of *Bauhinia,* having a similar leaf to that of *B. pauletia,* but doubtless specifically different from it. The spores of the type are slightly smaller for the most part than are those from the Porto Rican material. One collection has been examined from Mexico on *B. divaricata.* All collections agree in showing only telia, and in having the appearance of a micro-form, that is, in being short-cycled and incapable of germination immediately upon maturity.

24. UROMYCES APPENDICULATUS (Pers.) Fries, Summa Veg. Scand. 514. 1849.

Nigredo appendiculata Arth. Result. Sci. Congr. Bot. Vienne 343. 1906.

ON FABACEAE:

Phaseolus adenanthus G. Meyer, Vega Baja, Feb. 22, *374 bis;* Mayagüez, May 8, *1139.*

Phaseolus vulgaris L., Cabo Rojo, June 15, *2270.*

Vigna repens (L.) Kuntze, Arecibo, May 21, *1760.*

Vigna vexillata (L.) A. Rich., Mayagüez, June 14, *2216.*

The species has also been collected in Porto Rico on *P. adenanthus* by E. W. D. Holway, Caguas, January, 1911, by Mr. & Mrs. A. A. Heller on a phanerogamic specimen, Rio Piedras, April, 1889, *1221*, and by Britton & Cowell on a phanerogamic specimen, near Arecibo, March 14, 1908, *308*; and also on *P. vulgaris* by F. S. Earle, La Carmelita, June, 1903, *110*, and by G. P. Clinton, same locality, Apr. 18, 1904, *124*. The last collection bears teliospores as well as urediniospores.

On phanerogamic specimens in the herbarium of the New York Botanical Garden the uredinial stage has been found on both *Vigna repens* and *V. vexillata* from Cuba.

While the pores in the urediniospores of this species are usually two or three, and equatorial, as given in the N. Am. Flora 7: 257, they are sometimes four in number, and sometimes are distinctly superequatorial. The Stevens' collections from Porto Rico show

only uredinia, and the spores are 2-pored. On *Phaseolus* the pores are mostly equatorial, but on *Vigna* they are markedly superequatorial.

25. UROMYCES DOLICHOLI Arth. Bull. Torrey Club 33: 27. 1906.
Puccinia Dolichi Arth. Bull. Torrey Club 33: 28. 1906.
Uredo Dolichi Arth. Bull. Torrey Club 33: 513. 1906.
Nigredo Dolicholi Arth. N. Am. Flora 7: 258. 1912.

ON FABACEAE:

Cajan Cajan (L.) Millsp. (*Cajanus indicus* Spreng.), Guayanilla, Jan. 4, *87*; Corozal, Feb. 21, *418*; Jayuya, March 31, *693*; Rosario, Oct. 27, *3832*; Mayagüez, Oct. 27, *3861*; Vega Baja, Nov. 5, *4241*; Menati, Nov. 5, *4307*; Quebradillas, Nov. 22, *5119*.

Dolicholus reticulatus (Sw.) Millsp. (*Glycine reticulata* Sw., *Rhynchosia reticulata* DC.), Boqueron, Feb. 15, II, *337*; Aguada, Nov. 22, II, *5091*; Vega Baja, May 18, *2048*.

A collection was made on *D. reticulatus* by A. A. Heller at Limestone Hills near Bayamon, Jan. 21, 1903, and on *C. Cajan* by J. A. Stevenson *2474*, at Campoalegre, Dec. 22, 1914. The species has also been found on a phanerogamic specimen of *C. Cajan* from St. Domingo.

The type collection of this species is in the Arthur Herbarium at Lafayette, Ind., and was obtained at San Angelo, Texas, Oct. 19, 1904, by C. L. Shear. The host was determined by Dr. E. L. Greene as *Rhynchosia texana* T. & G., now called *Dolicholus texanus* (T. & G.) Vail. It consists of a few intertwined stems, and about twenty two small, well-rusted leaves. The same collection was issued in Bartholomew, Fungi Columbiani *4091*.

A re-examination of the type collection shows that a more exact statement in the description of the species would be to say *pores 2 to 4, usually three,* instead of "pores 4." This statement of the pore-character also better fits other collections recently studied, and especially the Porto Rican ones here listed.

The collection named *Puccinia Dolichi* from a few teliospores, afterwards found to be strays, and then called *Uredo Dolichi,* was made by E. W. D. Holway, at Aguacate, Cuba, March 23,

1903, and was labeled as on "*Dolichos reticulatus*." The genus *Dolichos*, according to Engler & Prantl, Pflanzenfamilien, is closely related to *Phaseolus* and *Vigna*, genera which bear *Uromyces appendiculatus*, and to this species the rust was accordingly assigned in the North American Flora, vol. 7, page 257. The authority, "Hochst." for the name of the host was supplied from the Kew Index. Recently, becoming suspicious of the correctness of the name, the type material was submitted to the New York Botanical Garden, and it has been determined by Mr. Percy Wilson, March 6, 1915, as *Dolicholus reticulatus* (Sw.) Millsp. The latter genus belongs to a different group of genera from that of *Dolichos*. The rust on the Cuban host agrees well with that from Texas, except that it shows only uredinia.

Two collections of this species from South America have been examined, and show uredinia which agree well with the North American material. One was collected by M. St. Pennington, near San Fernanda, Argentina, 1902, on *Rhynchosia Senna* Gill. The other was issued in Spegazzini's Dec. Myc. Arg. *20*, and was collected by Spegazzini in 1881, at Bagnado de San Jose de Flores, Argentina, on "*Rhyncosia*" sp. The two collections are given the same name, *Uredo pamparum*, and appear to be on the same host. The locality for the latter collection is the place where Spegazzini collected the type of *Uredo pamparum*, one year earlier. In Anal. Soc. Ci. Argent. vol. 9, page 173, this last species is established as on *Phaseolus prostratus*, a determination which for a variety of reasons the writer believes to have been an error for *Rhynchosia* (*Dolicholus*) *Senna*.

A collection of the same species of rust on still another species of *Rhynchosia*, thought to be *R. longeracemosa* Mart. & Gall., has been included in Mayor's Contribution à l'étude de Urédinees de Colombie, and said to agree well with the North American *U. Dolicholi*, under which name it is listed.

The several collections on *Cajanus indicus* show such close agreement in the spore and sorus characters with those on *Dolicholus reticulatus*, and the hosts being closely akin, there seems ample reason for placing them here. So far as one can judge from the description, *Uredo Cajani* Syd. (Ann. Myc. 4: 442.

Oct., 1906) refers to the same rust. All West Indian collections so far seen on this host show uredinia only, usually with three equatorial pores in the urediniospore.

26. UROMYCES HEDYSARI-PANICULATI (Schw.) Farl.; Ellis, N. Am. Fungi *246*. 1879.

Uromyces solidus Berk. & Curt. Grevillea 3: 57. 1874.

Nigredo Hedysari-paniculati Arth. Result. Sci. Congr. Bot. Vienne 343. 1906.

ON FABACEAE:

Meibomia axillaris (Sw.) Kuntze (*Desmodium axillare* DC.), Cabo Rojo, June 15, *2259*.

Meibomia Scorpiurus (Sw.) Kuntze (*Desmodium Scorpiurus* Desv.), Mayagüez, May 24, *1375*; Peñuelas, Dec. 15, *5936*.

The collections here included possess only uredinia, which are, however, in every way typical of the species. The spores are broadly ellipsoid, often globoid, 18–21 by 21–24 μ; wall chestnut-brown, about 1.5 μ thick, the pores 3–5, scattered, or sometimes appearing equatorial. Thin-walled, hyphoid, paraphyses are present.

This rust has not before been reported from the West Indies. I have, however, been able to detect it on phanerogamic collections in the herbarium of the New York Botanical Garden. It occurs on a specimen of *M. Scorpiurus* collected by A. A. Heller, near Yauco, P. R., Dec. 15, 1902, and on the same host collected by Percy Wilson, at Rio San Miguel, Cuba, Dec. 17, 1910, *9380*.

Through the kind assistance of Mr. Percy Wilson the rust has also been brought to light from the same source on *Meibomia tortuosum* (Sw.) Kuntze, collected at Yauco, P. R., Oct. 3, 1913, by Stevens & Hess, *3252*, and collected in Cuba, near Vento, 1907, Baker, Tracy & Hasselbring *3079*, and near Herradura, 1910, Britton & Earle *6591*.

The same rust on both *M. Scorpiurus* and *M. tortuosum* is known from the southern part of continental North America. All the collections here referred to show only uredinia, but they appear to be identical with authenticated material of the species.

It has not been possible to examine type material of *Uredo Desmodii-tortuosi* P. Henn. (Hedwigia 35: 252. 1896), which was founded on a collection of *Meibomia tortuosum* from Fajardo, P. R., April 17, 1885, O. Sintenis. However, the claim of the author that it is distinct from *Urom. Hedysari-paniculati* by reason of its smooth spores, seems open to doubt. As no rust is known having truly smooth urediniospores, it is probable that Hennings' material possessed fine echinulation, which was overlooked. As all other terms of the characterization accord well with the common species on *Meibomia,* it may tentatively be assumed that the form named by Hennings is not essentially distinct.

27. UROMYCES NEUROCARPI Dietel, Hedwigia 34: 292. 1895.
Uromyces insularis Arth. Bull. Torrey Club 33: 515. 1906.
Nigredo Neurocarpi Arth. N. Am. Flora 7: 258. 1912.

ON FABACEAE:

Clitoria cajanifolia (Presl) Benth. (*Neurocarpum cajanifolium* Presl), Mayagüez, Jan. 30, *344*; without locality or date (in letter dated June 18, 1913), *2146c.*

Clitoria rubiginosa Juss. (*C. glycinoides* P. DC.), Dorado, Nov. 25, *5314*, *5315*.

No pycnia or aecia have yet been discovered for this species, but it is highly probable that they occur occasionally. Telia, in addition to uredinia, are shown only on no. *344* of the specimens here listed.

The type collection of *U. insularis* was on *C. cajanifolia,* from Dorado, P. R., 1887. The species was also collected on this host near San Juan, in 1914, by Britton and Cowell *1469*. On *C. rubiginosa* it has been found at Santurce, P. R., Feb., 1914, by J. R. Johnston *1339*, and in both Jamaica (1906) and Cuba (1903).

28. UROMYCES PROËMINENS (DC.) Pass. Rab. Fungi Eur. *1795*. 1873.

Uromyces Euphorbiae Cooke & Peck; Peck, Ann. Rep. N. Y. State Mus. 25: 90. 1873.

Uromyces euphorbiicola Tranz. Ann. Myc. 8: 8. 1910.
Nigredo proëminens Arth. N. Am. Flora 7: 259. 1912.

ON EUPHORBIACEAE:

Chamaesyce hirta (L.) Millsp. (*Euphorbia hirta* L., *E. pilulifera* L.), Cataño, Nov. 6, *4154*; Vega Baja, Nov. 5, *4325*; Lares, Nov. 22, *4839 bis;* Coamo Springs, Nov. 16, *4906*; Aricebo, Nov. 22, *5015*; Aguado, Nov. 22, *5104*; Guayama, Dec. 4, *5339*; Rio Piedras, Nov. 13, *5703*; San German, Nov. 8, *5804*; Guayanilla, Nov. 13, *5868*.

The species has also been collected on *C. hirta* at Mayagüez, by G. P. Clinton in April, 1904, *169*, and at Camuy, by Underwood & Griggs in July, 1901, *199*.

Material has been examined from other West Indian islands as follows: Bahamas, on *C. hypericifolia* (L.) Millsp., *C. prostrata* (Ait.) Small, and *Poinsettia heterophylla* (L.) Kl. & Garcke; Cuba, on *P. heterophylla;* Jamaica, on *C. hirta* (L.) Millsp., *C. prostrata, C. serpens* (H.B.K.) Small, and *P. heterophylla;* St. Croix, on *C. prostrata;* all of which collections but one are cited in the North American Flora, vol. 7, pp. 260, 261.

29. **Uromyces Janiphae** (Wint.) comb. nov.

Uredo Janiphae Wint. Grevillea 15: 86. 1887.
Uromyces dichrous Vesterg. Micr. Rar. Sel. *1516*. 1913. Hyponym.

ON EUPHORBIACEAE:

Manihot Manihot (L.) Cockerell (*M. utilissima* Pohl, *Jatropha Manihot* L., *Janipha Manihot* H.B.K.), Vega Baja, Nov. 5, II, *4261*.

This rust appears to be common in the warm regions of America on various forms of the cultivated cassava. That it occurs in the Old World as well is probable, but I have seen no specimens. Winter's description was founded on material collected near Sao-Francisco, Brazil, in 1887, by E. Ule *362*. Vestergren's material was collected by E. W. D. Holway at Guadalajara, Mexico, in 1903, and is the only collection known to the writer showing both uredinia and telia. The original num-

ber of the collection is *5050*. The same collection has been issued in Vestergren's Micr. Rar. Sel. *1516*, and in Bartholomew's Fungi Columb. *4093*, and N. Am. Ured. *391*. Whether the species possesses aecia or not is not yet known.

The species differs from *Uromyces Jatrophae* Diet. & Holw., for which it has been mistaken and to which it is closely related, by the thicker-walled urediniospores, and the dark-beaked teliospores.

The species on the same host has also been collected on the island of Jamaica by E. W. D. Holway, Feb. 17, 1915, *211*.

30. UROMYCES CESTRI Mont. in Gay, Hist. Chile 8: 49. 1852.
Aecidium Cestri Mont. Ann. Sci. Nat. II, 3: 356. 1835.
Uredo Cestri Mont. Prodr. Flor. Fernandes, no. 35. 1835.
Uromycopsis Cestri Arth. Result. Sci. Congr. Bot. Vienne 345. 1906.

ON SOLANACEAE:

Cestrum laurifolium L'Her., Cabo Rojo, June 15, *2251*; Monte Alegrillo, Nov. 14, *4822*; Quebradillas, Nov. 22, *4995*; San German, Nov. 8, *5823*; Arecibo—Lares road, Jan. 21, 1914, *6787*; Arecibo, Jan. 17, 1914, *6803*.

Cestrum macrophyllum Vent., Barros, Jan. 2, *124*, *144*; Maricao, Jan. 10, 1912, *230*, April, I and III, *771*, April 3, *772*, no date, *3499*; Rio Maricao above Maricao, Sept. 20, 3640; Ponce, Nov. 8, *4353*, *4364*; Monte Alegrillo, no date, *4719*, Nov. 14, *4766*; Lares, Nov. 22, *4847*; Luguillo forest, Dec. 2, *5550*, *5605*; Monte de Oro, Dec. 3, *5713*; River junction below Utuado, Dec. 16, *6036*, Dec. 17, *6050*, Dec. 30, *6515*; Preston's ranch, Dec. 31, *6708*.

The aecia produce a considerable hypertrophy, and the peridia being evanescent, the spots soon take on the appearance of insect galls. The telia are not common, only one of the collections, no. *771*, showing a few sori on the same leaf with aecia. No pycnia of this species have yet been recorded.

The species is also known on three other West Indian islands: Jamaica, St. Jan and Tortola.

31. UROMYCES HELLERIANUS Arth. Bull. Torrey Club **31**: 2. 1904.

Nigredo Helleriana Arth. N. Am. Flora **7**: 267. 1912.

ON CUCURBITACEAE:

Cayaponia americana (Lam.) Cogn., Maricao, *723*; Cabo Rojo, Dec. 27, *6459*.

Cayaponia racemosa (Sw.) Cogn., Corozal, Feb. 21, *422*.

Melothria guadalupensis (Spreng.) Cogn., without locality or date (1913 ?), *614*; Yauco, Oct. 3, *3130*; Rosario, Oct. 27, *3840*; Utuado, Nov. 8, *4398*, *4415*; San German, Dec. 12, *5838*.

This species has not been reported outside of Porto Rico, except one collection from Guatemala, but was found on a phanerogamic specimen at the New York Botanical Garden, on *M. guadalupensis* from Buenaventura, Cuba, collected by Percy Wilson, Dec. 13, 1910, *9237*. The type collection on *C. racemosa* was obtained by A. A. Heller, on the Adjuntas road eight miles from Ponce, Dec. 4, 1902. The species has been placed in the genus *Nigredo* without knowledge of pycnia or aecia, but on the assumption that they occur whenever favorable conditions permit the life cycle to be completed.

32. UROMYCES GEMMATUS Berk. & Curt.; Berkeley, Jour. Linn. Soc. **10**: 357. 1869.

ON CONVOLVULACEAE:

Jacquemontia nodiflora (Desv.) G. Don (*Convolvulus nodiflorus* Desv.), Coamo Springs, Jan. 4, O, I, III, *42*, Feb. 1, O, II, III, "*y*," Jan. 1, O, II, *128*, April 6, II, III, *818c*; Desecheo, May 31, II, III, *1586*; San German, Dec. 8, II, III, *5765*, Dec. 12, II, III, *5859*; Dec. 18, II, III, *4121*; Guanica, Dec. 29, II, III, *6827c*; Guayanilla, Nov. 13, II, *5928*.

The only other specimens of this exclusively West Indian rust known to the writer are one made by A. E. Ricksecker on St. Croix in 1896, listed in Millspaugh's Flora of St. Croix (Field Mus.; Bot. Ser., **1**: 466. 1902), as *Puccinia Convolvuli,* one made by E. W. D. Holway at Ponce, P. R., Jan., 1911, and one

made by Holway at Kingston, Jamaica, Feb., 1915, *223*, all three showing uredinia and telia.

A specimen collected by Charles Wright in "Cuba orientali, 1856–7," which is in the Curtis set at Harvard University, is labeled "*Uredo gemmata* B. & C., var." Through the kindness of Dr. W. G. Farlow I have been able to study this collection and believe it to be identical with the material on which *Uromyces gemmatus* B. & C. was founded, which was stated to be "on the underside of leaves of *Convolvulus* etc." With the aid of Mr. Percy Wilson of the New York Botanical Garden the host has been determined with certainty as *Jacquemontia nodiflora*. The fungus consists of uredinia only, and agrees exactly with the description given by Sydow (Ann. Myc. **6**: 138. 1908), said to have been taken from a part of the type material, and also with the uredinia in the fine set of specimens collected by Dr. Stevens. A full description is given to aid in making the species better known.

Pycnia epiphyllous, few in small groups on somewhat discolored spots, inconspicuous, subepidermal, globoid-flask-shaped, 65–135 μ broad by 96–170 μ high; ostiolar filaments 25–30 μ long.

Aecia uredinoid (primary uredo), chiefly hypophyllous, circinate about the area occupied by pycnia, round or oblong, often confluent, otherwise like the uredinia.

Uredinia hypophyllous, scattered or sometimes grouped, round, about 0.5 mm. across, soon naked, cinnamon-brown, somewhat pulverulent, ruptured epidermis noticeable; urediniospores ellipsoid or obovoid, 24–27 by 31–35 μ; wall cinnamon-brown, moderately thick, 2–3 μ, prominently echinulate, the pores about 6, scattered.

Telia hypophyllous, similar to the uredinia but somewhat darker in color, often arising in the same sori; teliospores ellipsoid or obovoid, 23–29 by 32–43 μ, rounded above, somewhat narrowed below; wall cinnamon-brown, thin at sides, 1 μ, greatly thickened above, 7–20 μ, smooth; pedicel nearly or quite colorless, thin-walled, one half to once length of spore.

The *Uredo Jacquemontiae* P. Henn. from New Guinea is described as having considerably larger spores, with wall 5–7 μ thick, echinulate with hyaline points 1 μ long, and is clearly distinct from the West Indian form.

33. UROMYCES COLUMBIANUS Mayor, Mem. Soc. Neuch. Sci. Nat. 5: 467. 1913.

ON CARDUACEAE:

Melanthera canescens (Kuntze) O. E. Schultz, Ciales, June 12, 1912, *28*; Añasco, Jan. 28, *234*, *274*, Oct. 12, *3564*, *3568*; Corozal, Feb. 12, *421*; Yauco, Oct. 3, *3138*; Mayagüez, April 12, *1022*; Vega Baja, May 18, *2041*, *2045*, May 21, *1895*, *1910*, *1922*; Cayey, June 5, *2175*; Cabo Rojo, June 15, *2255*; Rosario, Oct. 27, *3837*; Utuado, Nov. 8, *4423*, *4684*; Quebradillas, Nov. 22, *5190*; San German, Dec. 12, *5831*, *5834*; Guayanilla, Nov. 13, *5917*, *5918*; River junction below Utuado, Dec. 16, *6039*, Dec. 17, *6070*, Dec. 30, *6860*, *6864*; Jayuya, Dec. 17, *6044*, *6045*.

The rust was obtained on the phanerogamic collection of the same host species made by Mr. & Mrs. A. A. Heller *138*, near Rio Piedras, P. R., May 13, 1899.

Since the work on Steven's Porto Rican rusts began, the excellent and detailed study of the rusts of the United States of Colombia by Dr. Eug. Mayor of Neuchatel, Switzerland, has been issued. In this work is a full description of the aecia, uredinia and telia, with a fairly good cut illustrating the urediniospores and teliospores of this species. The type is on *Melanthera aspera* (Jacq.) Steud., Andes centrales, dép. Antioquia, Medellin and Envigado, alt. 1550 m., II and III, August 19, no. *256*, supplemented by a number of other collections.

Pycnia occur in the Stevens collection on nos. *28*, *1910*, *1922*, *2045*, *2175* and *5917* accompanying the aecia, and probably on a number of others. In each case the collection also shows uredinia and telia. The pycnia are subepidermal, globoid or flask-shaped, inconspicuous, about 100 μ in diameter.

The rust bears the usual characters that entitle it to a place in the genus *Nigredo*, in which it becomes **Nigredo columbiana** (Mayor) comb. nov.

The host belongs to a group of forms that is difficult of separation into species. The Stevens collections are fortunately well supplied with inflorescence at various stages of maturity. Some

of the material resembles *Melanthera deltoides,* and some *M. hastata cubensis,* but the careful study given to the whole set by Mr. Percy Wilson of the New York Botanical Garden, in which he was assisted by other members of the staff, makes it seem best to assign all the Stevens collections to *M. canescens.*

34. UROMYCES BIDENTIS Lagerh. Bull. Soc. France 11: 213. 1895.

Uredo Bidentis P. Henn. Hedwigia 35: 251. 1896.
Uredo bidenticola P. Henn. Hedwigia 37: 279. 1898.
Uredo amaniensis P. Henn. Engler's Bot. Jahrb. 38: 106. 1905.

ON CARDUACEAE:

Bidens leucantha Willd., Santurce, Jan. 22, *269*, June 5, *2176*; Vega Baja, Feb. 20, *470*, May 21, *1731*, Nov. 5, *4280*; Aibonito, June 5, *2146*; Añasco, Oct. 12, *3532*; Mayagüez, Oct. 31, *3952*; Monte Alegrillo, without date, *4713*; Lares, Nov. 22, *4927*; Aguada, Nov. 22, *5093*; River junction below Utuado, Dec. 30, *6583*.

Cosmos caudatus H.B.K., Barros, Jan. 2, II, *63*; Jayuya, Dec. 17, II, *5988*.

Most of the Stevens collections show uredinia only. It has been collected in Porto Rico also by E. W. D. Holway, San Juan, January, 1911, showing both uredinia and telia.

Specimens of the species have been seen from Martinique on *B. leucantha,* Hahn, and on *B. pilosa,* Sieber, and from Jamaica on *B. leucantha,* Underwood *1749*, Holway *214*, and on *Cosmos caudatus,* Underwood *1149*.

The type collection is on *Bidens andicola,* near Quito, Equador, Lagerheim, and has not been seen by the writer. A collection on the same host from Guatemala, December, 1887, J. J. Cooper, shows uredinia and telia.

The species is autoecious, and what is often called a hemi-uromyces, showing ordinarily only uredinia and telia. However, on collections by E. W. D. Holway, on *B. tereticaulis,* Jalapa, Mexico, *3210* (Barth. N. Am. Ured. *782*), and Oaxaca, Mexico, *3667*, and also by F. L. Stevens, on *B. pilosa,* Caracas, Venezuela,

3006, there occur pycnia and uredinoid aecia (primary uredo), which give the following characters:

Pycnia amphigenous, numerous in small groups, honey-yellow becoming darker, subepidermal, globoid, 100–140 μ in diameter; ostiolar filaments few, 20–30 μ long; basidiospores large, 5–7 μ in diameter.

Aecia uredinoid, amphigenous, circinating about the groups of pycnia, resembling the uredinia, but somewhat larger and less pulverulent; aeciospores pedicellate, resembling the urediniospores.

The uredinia and telia are described elsewhere, and especially well, by Sydow, Monog. Ured. 2: 3. 1909. The characters given above entitle the species to be placed in the genus *Klebahnia*, in which it should be **Klebahnia Bidentis** (Lagerh.) nov. comb.

35. **Uromyces densus** sp. nov.

Telia hypophyllous, numerous, in small groups on slightly discolored spots, pulvinate, coalescent, all sizes from 0.1 to 1 mm. in diameter, often a central, large, cushion-shaped sorus surrounded by smaller ones, frequently in a circle, dull cinnamon-brown becoming cinereous by germination; teliospores obovoid or oblong, 16–23 by 24–38 μ; wall pale cinnamon-brown, thin, 1–1.5 μ, thicker above, 3–9 μ, smooth; pedicel nearly colorless, delicate, once or twice length of spore.

ON CARDUACEAE:

Bidens pilosa L., Ponce, Nov. 8, *4266*.

The same species was collected on *B. leucantha* at La Carmelita, P. R., April 18, 1904, by G. P. Clinton.

The species was also collected on *B. pilosa* at Caracas, Venezuela, July 15, 1913, by Dr. Stevens, *2978*, *2982*, *2998*, *3007*.

All these collections show the same characteristics of dense groups of sori, centrally cinereous from germination of the spores. The appearance is wholly unlike that of *Uromyces Bidentis* with its low, small sori, which do not coalesce and thicken into cushions. The teliospores, however, are essentially alike in the two species. *U. densus* is to be considered a short-cycle form, for which *U. Bidentis* is the corresponding long-cycle form.

(*To be continued*)

ILLUSTRATIONS AND DESCRIPTIONS OF CUP-FUNGI—II. SEPULTARIA

Fred J. Seaver

(With Plate 161, Containing 3 Figures)

The genus *Sepultaria* was founded by Massee,[1] the name having been first used by Cooke for a subgenus of *Peziza.* The genus was based on *Peziza sepulta* Fries,[2] one of the few species of true hypogaeous cup-fungi.

Previous to the publication of *Peziza sepulta* by Fries, Léveillé[3] described a species with similar characters under the name of *Peziza arenicola.* According to Léveillé, the latter species is peculiar in its mode of development, since the apothecia are at first subglobose and entirely concealed in the ground. After abundant rains they open and then for the first time become visible. The outer surface is covered with long fine hairs which bind the sand to the outside of the apothecia so closely that it is not easily detached.

According to Berkeley and Broome who published Fries's manuscript name of *Peziza sepulta,* this species is closely related to *Peziza arenicola* Lév. and also has a close resemblance to *Hydnocystis* Tul. The plants of the latter genus are said by Tulasne not to open to the surface and in this respect only they differ from those of *Sepultaria. Hydnocystis* is commonly placed among the Tuberales.

The writer has examined a specimen of *Peziza arenicola* Lév. from Léveillé and also a specimen of *Peziza sepulta* Fries from Scandinavia and find that the two are identical.

What appears to be the same species has been frequently collected by Professor Ellsworth Bethel in the vicinity of Denver, Colorado. He writes that the fungus is entirely submerged with

[1] Massee, Brit. Fungus Fl. 4: 389. 1895.

[2] Ann. Mag. Nat. Hist. II. 13: 463. 1854.

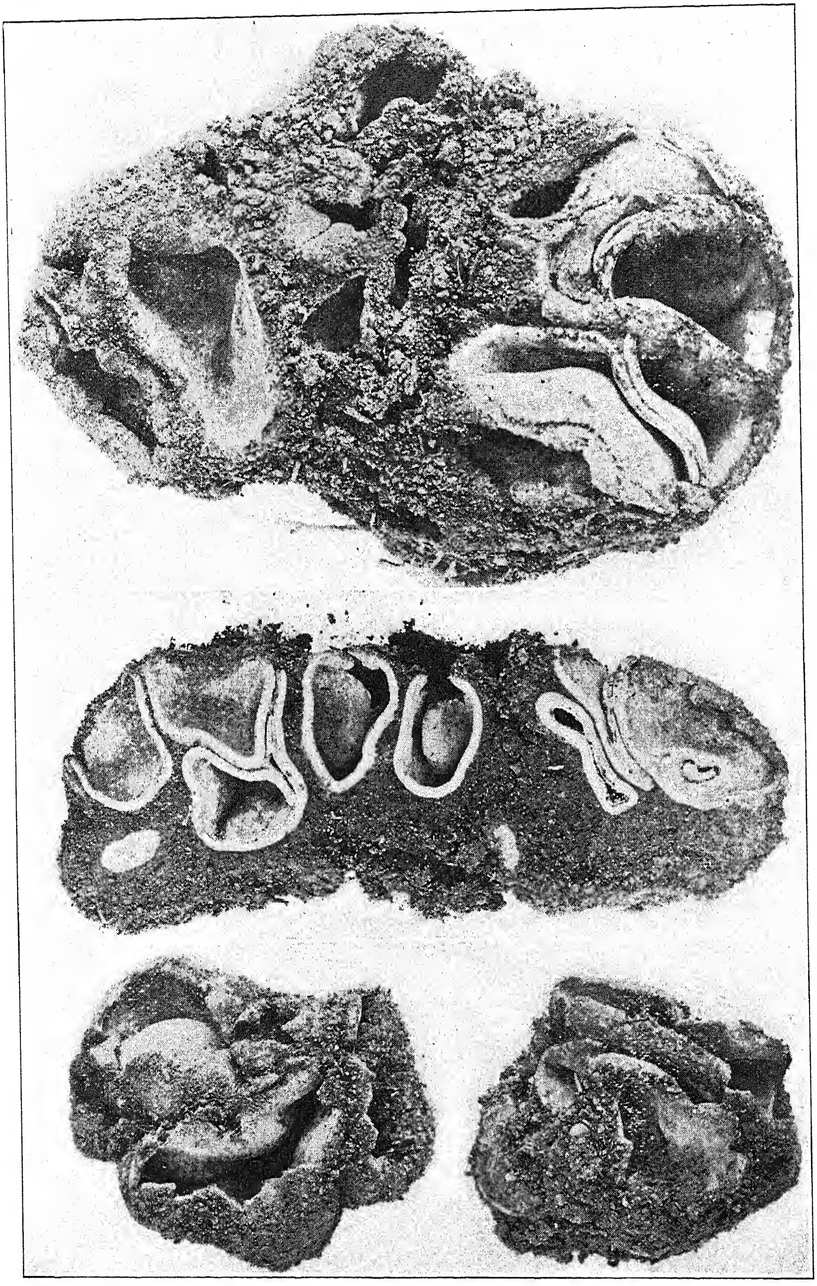
[3] Ann. Sci. Nat. III. 9: 140. 1848.

them and is frequently collected by his students who know it as the "*hole in the ground*," since they find it by looking for holes in the sandy soil. Mr. Ellis was at first inclined to regard the Colorado plants as a new species but finally came to the conclusion that the species was identical with *Peziza sepulta* Fries, according to notes in the Ellis Collection.

The writer has recently received from Mr. W. H. Long in New Mexico fine specimens of a *Sepultaria* which closely resembles the species so frequently collected by Bethel in Colorado. According to the collector, the New Mexican plants do not protrude above ground at all in any of the thirty or forty specimens collected, although the soil is said to be slightly raised when the apothecia break. When mature, small cracks appear in the tops of the apothecia which if the soil is not too firm around them will expand and finally expose some of the hymenium. The New Mexican material was shipped fresh and was received in excellent condition. From some of this material the accompanying photographs were made.

While the New Mexican plants are closely related to *Sepultaria arenicola* (Lév.) Massee, they seem to differ in the form of the spores which are ellipsoid but only slightly longer than broad, while those of the former are often twice as long as broad. Aside from this, the New Mexican plants appear to differ in general habits. Gross characters, however, such as congested habit are taken with considerable allowance since the writer has had no opportunity to make a study of the Colorado plants in a fresh condition and the New Mexican plants are known only from the specimens described here. From the studies which have been made, the New Mexican plants are regarded as distinct.

Specimens which have been referred to *Sepultaria arenicola* (Lév.) Massee, have occasionally been collected in different parts of the east, although the species seems like the one here described to be characteristic of the dry plains of the west. A number of other species have been referred to the genus which are smaller and only partially buried. So far as known, the genus at present contains five species for North America, including the one here described.



SEPULTARIA LONGII SEAVER

The genus should not be confused, as has often been done, with *Sarcosphaera* which differs from *Sepultaria* in the absence of the long brown hairs which are so characteristic of the plants of the latter genus. The two genera agree in that both are hypogaeous. So far as habits are concerned, *Sepultaria* seems to be intermediate between the Pezizales and the Tuberales although with the exception of *Hydnocystis* the fruit characters are not nearly so suggestive of the Tuberales as are those of some other discomycete genera such as *Boudiera* and *Lamprospora*. However that is a question for the morphologist.

Sepultaria Longii sp. nov.

Apothecia densely gregarious or cespitose, at first closed and entirely buried, finally opening to the surface by an elongated or compressed aperture, or when the substratum is not too compact spreading so as to expose the hymenium, never protruding above the surface of the substratum but causing the soil to become slightly elevated as they mature, reaching a diameter of 4 cm., regular in form or becoming very much contorted from mutual pressure, externally pale-brown and entirely clothed with long hairs which extend into the substratum, binding the surrounding soil closely to the outside of the apothecium; hairs flexuous, septate, brown, and of nearly uniform thickness throughout their entire length; asci subcylindric above, tapering gradually below into a stem-like base, reaching a length of 250–300 μ and a diameter of 20–22 μ; spores 1-seriate, short-ellipsoid or subglobose, at first containing one small oil-drop which gradually enlarges until it nearly fills the spore, about $18–20 \times 20–22\ \mu$; paraphyses stout, gradually enlarged above where they reach a diameter of 4–6 μ, filled with numerous vacuoles or oil-drops, hyaline.

On bare ground.

TYPE LOCALITY: Albuquerque, New Mexico.

DISTRIBUTION: Known only from the type locality.

EXPLANATION OF PLATE CLXI

Upper figure, group of apothecia partially concealed by the soil; middle figure, section through the cluster of apothecia showing their hypogaeous habit; lower figure, several apothecia removed from the soil.

A NEW FUNGUS, PHIALOPHORA VERRUCOSA, PATHOGENIC FOR MAN

E. M. Medlar

The fungus here briefly described was isolated from a chronic skin lesion on the buttock of a man 22 years old. The more detailed description may be found in a current number of the *Journal of Medical Research.*

The fungus grows on all ordinary laboratory media as a brownish-black, felt-like mycelium composed of ramified, septate hyphae which are cylindric, fairly straight, and composed of thick-walled cells $4–25 \times 2–6\mu$. Their protoplasmic content is finely granular and in it are embedded numerous fat droplets of varying size. By staining, a definite nucleus can be demonstrated in each cell as shown in the accompanying figure.

Sclerotic cells are formed under conditions which are unfavorable to normal growth, and are also produced in tissues and on hydrocele agar. These sclerotic cells may undergo a process of septation in more than one plane and in this way form small sclerotium-like cell-masses.

Reproduction, so far as known, is entirely asexual, and takes place by two types of conidial formation. The type of conidial formation found in cultures where conditions are most favorable for luxuriant growth is semi-endogenous in character. It occurs, as a rule, on specialized, short, lateral branches of the aerial hyphae, although at times the end segment of a hypha may become a conidium bearer. As a rule, these branches consist of a single sporogenous cell, although occasionally they may be composed of two or three cells from which the sporogenous cells may arise terminally and laterally. The sporogenous cells may arise singly or on opposite sides of the same vegetative cell, as indicated in the figure, and are usually ovoid in shape, forming during the process of fructification a shallow, round cup at the distal end. Into this cup the conidia are pushed as a result of the

successive proliferation of the sporogenous cell below. After reaching maturity a septum is formed between the conidium and the parent cell and another conidium is produced. Although these spores are set free as soon as they are formed and are never produced in coherent chains, they are not at once scattered, but remain coherent owing to the presence of a gelatinous material which holds them together. A dozen or more may thus cohere

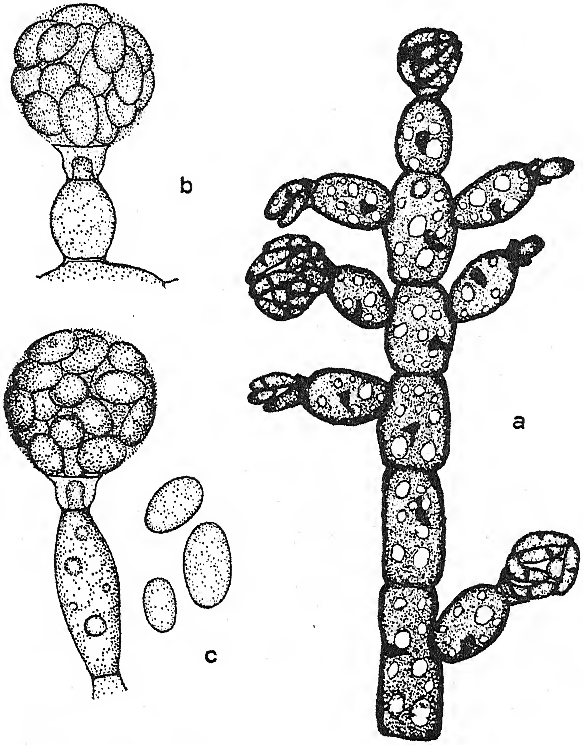


FIG. 1. *Philophora verrucosa* Medlar. *a,* stained specimen showing conidia formation and cellular detail; *b, c,* after Thaxter, showing detail of sporogenous cell and conidia.

to the cup-like extremity of the sporogenous cell forming a compact, globose mass. This "cup and ball" habit is very characteristic and the whole bears a close resemblance to a sporangium filled with endogenous spores.

The individual conidium has a definite wall which is at first hyaline or faintly yellowish and becomes brownish with age, a

finely granular protoplasm in which are embedded a few small fat droplets, and a definite nucleus. It varies from $4\,\mu$ to $6\,\mu$ in length and $1\,\mu$ to $3\,\mu$ in breadth.

The second type of conidial formation is found in tissues and in the depths of certain media, such as hydrocele agar. Here the conidia are formed as budding processes from single sclerotic cells, from the individual cells of the sclerotia, and from the end of short terminal and lateral branchlets. They may be single or in chains of two to six. The structure is similar to that of the conidia formed on the aerial hyphae, but the form is distinctly more ovoid.

Because the sexual reproduction, if there is any, of this fungus is unknown it will necessarily have to be classed among the Fungi Imperfecti. The color will place it under the Dematiaceae. So far as can be determined, there has never been described a fungus, either saprophytic, parasitic, or pathogenic for man or other animals, which corresponds closely to this form.

Professor Thaxter has suggested that the fungus should be classed under the sub-division Chalareae of Saccardo's Classification and should be the type species of a new genus, since the successive separation of the conidia and their coherence in a mucous mass which remains adherent to the cup-like apex of the sporogenous cell does not appear to be characteristic of any described genus in this section.

The name *Phialophora* (small shallow cup bearer) is proposed for the genus, and the specific name *verrucosa* is selected, as the lesion clinically resembled verrucous tuberculosis.

The fungus is pathogenic for rats and mice, producing lesions similar to those in man. Its natural habitat is unknown.

The determinative characteristics, as suggested by Professor Thaxter, of the new genus and new species are here given.

Phialophora gen. nov.

Mycelium of brown, septate, cylindric hyphae which show a tendency to cohere in rope-like strands, the ultimate branches and branchlets tending to become moniliform. Aerial conidia produced by specialized sporogenous cells which arise terminally or

laterally from the branches: abjointed at maturity, simple, formed through successive proliferation into the cup-like termination of the sporogenous cell to which they cohere in a globose, gelatinous mass. Sclerotic cells and spores in monilia-like chains are also produced in the substratum.

Phialophora verrucosa sp. nov.

Sporogenous cells short, ampullae-form or more elongate, usually terminal or irregularly distributed near the ends of the ultimate branchlets, the lips of the terminal cups spreading; spores ovoid to ellipsoid, somewhat variable in form and size, usually about $4–5 \times 2–3\,\mu$; hyphae $2–6\,\mu$ in diameter.

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TESTS ON THE DURABILITY OF GREENHEART

(NECTANDRA RODIAEI SCHOMB.)

C. J. Humphrey

(With Plate 162, Containing 6 Figures)

Greenheart is a tropical timber-tree,[1] belonging to the laurel family, which has a world-wide reputation for extreme durability. The species grows in South America and some of the West Indian islands and is commercially exploited for home consumption as well as for export trade. In its native home it is used generally where a durable timber is required, it being resistant not only to wood-destroying fungi, but also to marine borers and white ants. Oustide its habitat it finds its greatest use in marine construction, to which it is particularly adapted on account of its resistance to the teredo.

The wood is very hard, heavy (about 61 lbs. to the cubic foot when air dry), tough, very strong, and fine-grained. As in many tropical trees, annual growth rings are not distinguishable.

The proportion of sapwood in a log is usually high, ranging from 3 to 4 inches in thickness in trunks 18 to 24 inches in diameter. Trees under 12 inches usually consist largely of sapwood. It is said that dealers do not regard the sapwood as inferior to heartwood, but the tests below outlined indicate there is a marked difference.

Freshly-cut sapwood is pale-yellow, darkening on exposure; the heartwood may vary from pale-yellow to black. Under the microscope the wood appears very dense, being interspersed with numerous single or double vessels, whose cavities are frequently stuffed with cellular ingrowths, called tyloses (Plate 162, figs. 4, 5, 6). These tyloses, when very abundant, are said to give a darker appearance to the wood.

[1] Mell, C. D., and Brush, W. D. Greenheart. U. S. Forest Serv. Circ. 211. 1913.

The great durability of the wood has been mainly attributed to two factors, (1) the presence of the tyloses, which stuff the vessels and thus render them more difficult of penetration by fungus mycelium, and (2) the presence in the wood of certain alkaloids which may exert a preservative effect.

At least four alkaloids have been extracted from the wood and bark, among which may be mentioned bebeerine[2] (or biberine) of the formula $C_{18}H_{21}O_3N$, and nectandrine, $C_{20}H_{23}O_4N$. The former is said to be commercially exploited as a substitute for cinchona. It contains a methoxyl group, a phenolic hydroxyl group and a NCH_3 group.

The toxicity to fungi of these alkaloidal extracts from greenheart has not yet been determined by the writer, but it is the plan to make such tests later, in an effort to throw further light on the durability of this remarkable wood.

During 1913–14 the writer conducted a series of durability tests on both the heartwood and sapwood of greenheart timber. The material was sent to the Forest Products Laboratory, Madison, Wisconsin, from British Guiana for test purposes. The shipment consisted of a 13 by 13 inch square-hewn timber, upon which the bark was still adhering to the corners in strips an inch to an inch and a half wide. The sapwood was about two and a half inches thick, being largely confined to the corners, it being hewn away at the center of the faces.

Test blocks ⅝ by ⅝ by 2 inches long were sawed out from near the center to secure good heart material, while the sapwood specimens were cut from near the circumference at the corners, in many instances representing the extreme outer surface, and hence less than normal size on account of the wane (Plate 162, fig. 2).

Each block was tested singly in a large test tube 1¾ inches in diameter and 9 inches long, the sapwood and heartwood being tested against the same organisms. Seventy tube cultures were originally planned, using 35 species of wood-destroying fungi common to the United States, but certain failures incident to the experiment reduced this number somewhat.

[2] Henry, T. A. The plant alkaloids, pp. 414, 415. 1913.

The test blocks were oven-dried at 100 to 105° C. for 20 hours and weighed. To moisten again they were placed in a dish of tap water, brought to a boil, and allowed to cool.

The tube cultures were prepared by placing a layer of wet sterilized sphagnum moss in the bottom, followed by a layer of moist sterile sand up to about two-fifths the length of the tube. The test block was embedded in this sand for about one-half its length and surrounded by culture blocks of spruce or beech, the former being used in the case of fungi known to inhabit coniferous timber and the latter in the case of hardwood fungi. Over the whole was packed a layer of wet sphagnum. Tap water was then added to saturate the sphagnum and sand in the bottom and the tubes were then tightly plugged with absorbent cotton.

After sterilization of about 1 hour at 12 pounds steam pressure, the tubes were allowed to cool and were inoculated on August 28 and 29 with various wood-destroying fungi, among which are included many of the most active ones prevalent in the United States.

With the exception of *Merulius lachrymans,* which was placed in the incubator at 22 to 26° C., all the cultures were held at laboratory temperature, which varied considerably with the seasons. After one year the tubes were opened and the blocks examined. Plate 162, figs. 1 and 3, illustrate the method of test and the luxuriant mycelial development which was attained by the end of the test period.

Upon removal, the test blocks were oven-dried and re-weighed. Tables I and II present the essential data and results.

An examination of Table I shows that the heartwood of greenheart proved highly resistant, and in most cases practically immune, to all the fungi used, in spite of the fact that the organisms developed luxuriantly in the tubes. Very little effect on the wood was noted in a visual examination. Losses in weight under 0.5 per cent. are not recorded, as this may lie within the experimental error.

Table II shows a somewhat different state of affairs, for the

TABLE I

DURABILITY OF HEARTWOOD

Organism.	Oven Dry Weight (Grams).		Loss in Weight (%).	Growth of Organism.	Condition of Culture Blocks.	Condition of Greenheart Test Blocks
	Before Test.	After 1 Year.				
Lenzites betulina (L.) Fr. No. 629	15.89	15.72	1.1	Good.	Considerably rotted.	Not appreciably affected.
Lenzites sepiaria (Wulf.) Fr. No. 780	15.72	15.12	3.8	Luxuriant.	Thoroughly rotted.	Slightly softened at lower end.
Merulius lachrymans (Wulf.) Fr.* Germany.	15.95	15.50	2.8	do.	Considerably rotted.	do.
Merulius tremellosus (Schrad.) Fr. No. 127	17.09	16.85	1.4	do.	Thoroughly rotted.	Not appreciably affected.
Fomes annosus (Fr.) Cke. Pa.	16.37	16.35	....	Poor.	Considerably rotted.	do.
Fomes everhartii (Ell. & Gall.) Wis.	16.30	16.25	....	Luxuriant.	do.	do.
Fomes fomentarius (L.) Fr. Minn.	16.69	15.60	6.5	do.	Thoroughly rotted.	Slightly affected.
Fomes igniarius (L.) Fr. No. 6254	16.79	16.75	....	do.	Considerably rotted.	Not appreciably affected.
Fomes lobatus (Schw.) Ind.	15.18	14.94	1.6	do.	Thoroughly rotted.	do.
Fomes pinicola (Sw.) Fr. No. 6222	16.05	15.98	....	do.	do.	Slightly affected in small spot at one end.
Fomes roseus (A. & S.)Fr. No. 6364	16.35	16.35	....	do.	do.	Not appreciably affected.
Polyporus adustus (Willd.) Fr. No. 626	16.87	16.90	....	do.	do.	do.
Polyporus obtusus Berk Minn.	15.03	14.90	0.8	do.	Considerably rotted.	do.
Polyporus resinosus (Schrad.) Fr. No. 1043	16.54	16.50	....	do.	do.	do.
Polyporus sulphureus (Bull.) Fr. No. 6263	15.76	15.70	....	do.	Thoroughly rotted.	do.
Polystictus hirsutus Fr. No. 6390	16.85	16.85	....	do.	do.	do.
Polystictus versicolor (L.) Fr.† No. 639	15.13	15.00	0.9	do.	Considerably rotted.	do.
Trametes robiniophila Murr. No. 827	13.48	13.32	1.2	do.	Thoroughly rotted.	do.
Stereum fasciatum Schw. No. 627	16.39	16.32	....	do.	do.	do.
Stereum gausapatum Fr. No. 914	16.48	16.48	....	do.	Considerably rotted.	do.
Stereum rameale Schw. No. 954	16.70	16.70	....	do.	do.	do.
Flammula polychroa Berk. No. 888	16.18	16.15	....	do.	do.	do.
Lentinus lecomtei Fr. No. 945	16.27	16.10	1.0	do.	Thoroughly rotted.	do.
Lentinus lepideus Fr. No. 6258	17.16	17.12	....	do.	do.	do.

* Held in incubator at 22–26° C.

† Hole in bottom of tube allowed culture to dry out.

TABLE

DURABILITY OF

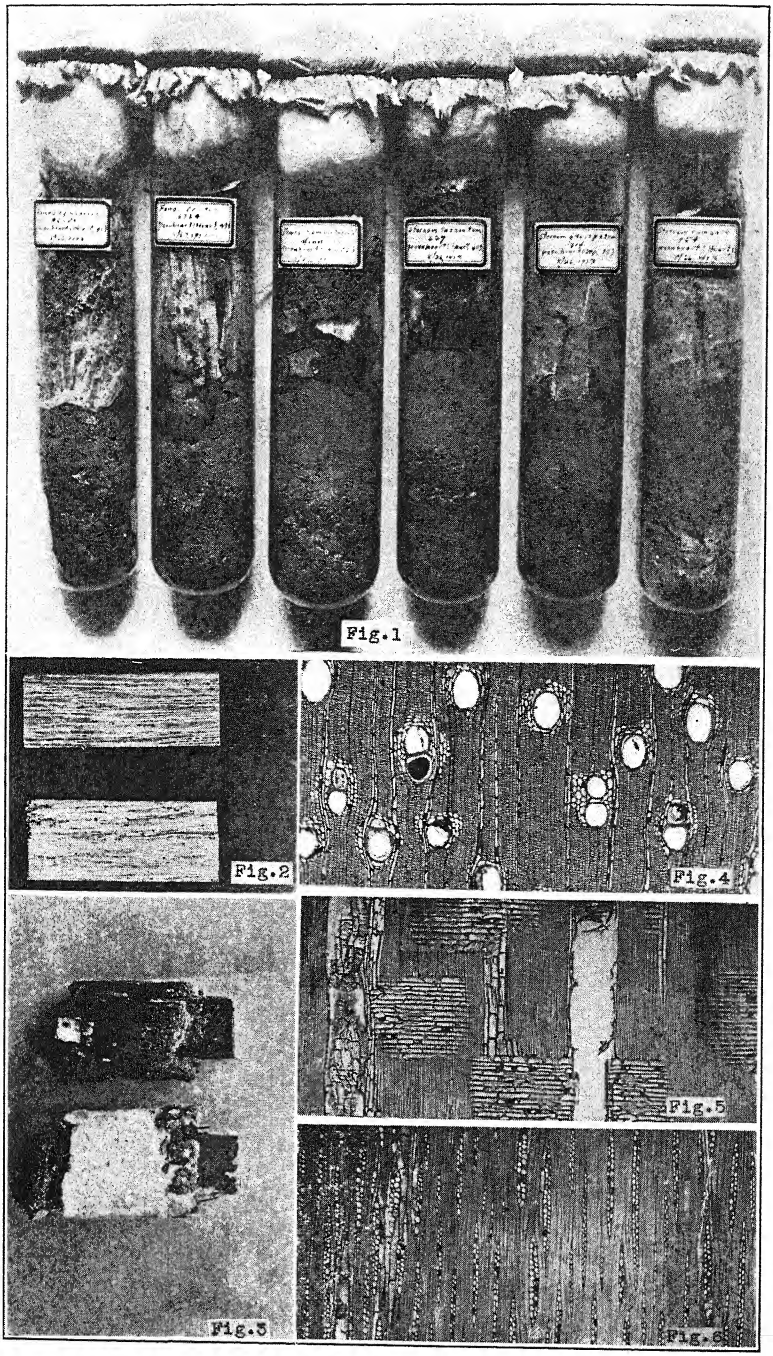
Organism.	Oven Dry Weight (Grams). Before Test.	After 1 Year.	Loss in Weight (%).
Lenzites betulina (L.) Fr. No. 629.......	8.79	8.40	4.4
Lenzites sepiaria (Wulf.) Fr. No. 780....	10.80	6.80	37.0
Merulius lachrymans (Wulf.) Fr.* Germany.	11.22	8.30	26.0
Merulius tremellosus (Schrad.) Fr. No. 127	9.52	8.43	11.4
Fomes annosus (Fr.) Cke...........Pa.	14.65	14.45	1.4
Fomes everhartii (Ell. & Gall.) .....Wis.	14.18	13.60	4.1
Fomes igniarius (L.) Fr. No. 6254......	14.40	11.32	21.4
Fomes lobatus (Schw.).............Ind.	12.93	9.80	24.2
Fomes pinicola (Sw.) Fr. No. 6222......	8.35	8.27	1.0
Fomes robiniae (Murr.) No. 859........	13.72	13.67	....
Fomes roseus (A. & S.) Fr. No. 6364....	14.65	14.45	1.4
Polyporus obtusus Berk...........Minn.	15.28	13.90	9.0
Polyporus resinosus (Schrad.) Fr. No. 1043	12.60	11.49	8.8
Polyporus sulphureus (Bull.) Fr. No. 6263	8.50	7.92	6.8
Polystictus hirsutus Fr. No. 6390.......	12.60	11.55	8.3
Polystictus prolificans (Fr.)........Wis.	10.71	10.17	5.0
Polystictus versicolor (L.) Fr. No. 639....	12.87	11.47	10.9
Stereum fasciatum Schw. No. 627.......	13.65	13.55	0.7
Stereum gausapatum Fr. No. 914.......	14.10	13.05	7.4
Stereum rameale Schw. No. 954.........	14.80	13.32	10.0
Flammula polychroa Berk. No. 888......	11.17	11.10	0.6
Lentinus lecomtei Fr. No. 945..........	13.03	10.75	17.5
Schizophyllum commune Fr. No. 885....	13.24	13.07	1.3

* Held in incubator at 22–26° C.

II

Sapwood

Growth of Organism.	Condition of Culture Blocks.	Condition of Greenheart Test Blocks
Luxuriant.	Thoroughly rotted.	Slightly affected.
do.	do.	Seriously rotted.
do.	Seriously rotted.	Seriously rotted at lower end.
do.	Thoroughly rotted.	Considerably rotted at both ends.
Poor.	Considerably rotted.	Not appreciably affected.
Luxuriant.	Thoroughly rotted.	Bleached and somewhat affected.
do.	do.	Considerably affected at lower end.
do.	do.	Considerably affected.
do.	do.	Not appreciably affected.
Good.	Considerably rotted.	do.
do.	do.	do.
Luxuriant.	do.	Considerably affected at ends.
do.	Thoroughly rotted.	Considerably affected.
do.	do.	Considerably affected at lower end.
do.	do.	Slightly affected at lower end.
do.	do.	Considerably affected at lower end.
do.	do.	Considerably affected.
do.	do.	Not appreciably affected.
Good.	do.	Slightly affected.
Luxuriant.	Considerably rotted.	Considerably affected at one end.
do.	do.	Slightly affected at ends.
do.	do.	Considerably affected.
Poor.	Slightly affected.	Not appreciably affected.



DURABILITY OF GREENHEART

sapwood proved far less resistant. *Lenzites sepiaria* proved the most active organism, producing a loss in dry weight of 37 per cent. *Merulius lachrymans* stands next with a loss of 26 per cent. Six other fungi produced losses ranging from 10 to 25 per cent. The wood remained practically immune to only three of the twenty-three fungi used.

The fact that the sapwood is more susceptible to decay than the heartwood meets our natural expectations, as this is the rule with timbers in which the heart and sapwood are differentiated.

The point to be kept in mind is that the sapwood, being so much less resistant to decay than the heart, should be carefully considered in timber specifications which call for the best quality of durable material. Not alone is the sapwood moderately susceptible to the attacks of fungi, but it is also reported to be more readily attacked by marine borers, and hence is said to be less valuable for wharf construction.

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DESCRIPTION OF PLATE CLXII

FIG. 1. Cultures in large tubes of six species of fungi, showing method of testing. Each tube contains a greenheart block surrounded by easily rotted culture blocks. After 1 year.

FIG. 2. Greenheart test blocks, heartwood above; sapwood, with wane, below.

FIG. 3. Greenheart block and beech culture blocks matted together by a heavy growth of mycelium at end of the test period. *Stereum fasciatum* above, *Polystictus hirsutus* below.

FIG. 4. Photomicrograph of transverse section of greenheart wood. Note the compact structure and tyloses partially filling the ducts. (By courtesy U. S. Forest Service.)

FIG. 5. Radial section of greenheart wood. (Courtesy of U. S. Forest Service.)

FIG. 6. Tangential section of same. (Courtesy U. S. Forest Service.)

OBSERVATIONS ON HERPOTRICHIA NIGRA AND ASSOCIATED SPECIES

Fred J. Seaver

Several years ago while attempting to work out the identity of *Herpotrichia nigra* Hartig and *Neopeckia Coulteri* (Peck) Sacc., the writer was surprised to find the ascospores of a third species on *Picea* which was at first thought to be an undescribed species of *Herpotrichia*. The spores of this species were fusiform, long and narrower than those of *Herpotrichia nigra* and, while usually 5-septate, were often 6-septate and occasionally even 7-septate, while those of *Herpotrichia* nigra were broad, blunt and never more than 3-septate so far as observed.

This strange species was first detected while studying Ellis & Everhart's Fungi Columbiani *1737*, a specimen of *Herpotrichia nigra* which was erroneously distributed under the name of *Lasiosphaeria Coulteri*. The spores of this species were again observed while examining a specimen of *Herpotrichia nigra* on *Picea Engelmanni* sent from Colorado by Bethel, July 7, 1914.

After a careful study it was found that these fusiform spores were not the spores of a *Herpotrichia* as at first suspected but were those of a *Mytilidion* which has been repeatedly found on conifers associated with *Herpotrichia nigra*. The genus *Mytilidion* belongs to the Hysteriales and the perithecia of the plants of this genus are laterally compressed and closely resemble a miniature clam or other bivalve, opening by a slit across the top of the perithecium and very different from the subglobose perithecia of *Herpotrichia*. The perithecia of the *Mytilidion* are, however, so intimately associated with those of the *Herpotrichia* that their real characters may be easily overlooked and when removed together, the spores of the *Mytilidion* may be mistaken for the mature spores of the *Herpotrichia*. If, however, the perithecia are removed and studied individually, it will be found that the fusiform spores are always obtained from the hysteriform perithecia while the subglobose perithecia contain the 3-septate spores which are characteristic of *Herpotrichia nigra*.

The *Mytilidion* is closely related to, if not identical with *Mytilidion fusisporum* (Cooke) Sacc., a species which has been reported on branches and bark of spruces and firs. Cooke's species is said to have spores 50 μ long, while the spores of our species have never been found to exceed 40 μ and are often not more than 30 μ. Having seen no authentic specimen of Cooke's species, it is impossible to know how much importance to attach to this apparent difference in the size of the spores. Our specimens have been doubtfully referred to that species.

The recent appearance of the description of a new species of *Herpotrichia* by Weir in the *Journal of Agricultural Research* has attracted the attention of the writer since the spores of his species were practically identical in size and form with those of the *Mytilidion* which has been so frequently found associated with *Herpotrichia nigra*. From the facts in hand the writer is inclined to believe that Weir's supposed new species is based on the combined characters of two different plants, the mycelial and perithecial characters being those of the well-known *Herpotrichia nigra* while the ascus and spore characters are those of the *Mytilidion.*

This suspicion has been strengthened by recent studies of our collections of *Herpotrichia nigra* which shows practically every specimen examined to be accompanied by the *Mytilidion,* the abundance of the latter species varying considerably in different specimens. To add to the difficulty the perithecia of the *Mytilidion* are often overrun by the mycelium of the *Herpotrichia* so that the perithecial characters are obscured. Not only has the *Mytilidion* been found on spruce needles associated with *Herpotrichia,* but it has also been found on pine needles associated in the same way with *Neopeckia Coulteri.*

Weir's drawings illustrate very well the spore characters of the three species, *Neopeckia Coulteri, Herpotrichia nigra* and the unnamed species of *Mytilidion* except that the spores of the last are not always 5-septate as indicated in his drawings but are often 6-septate and occasionally even 7-septate. The spore measurements are usually within the limits given by Weir, but spores are occasionally found as long as 38–40 μ. The color is pale-brown, as indicated by him.

NEW YORK BOTANICAL GARDEN.

NEWS AND NOTES

Professor George Massee, one of the associate editors of *Mycologia,* is reported to have retired from his position as head of the cryptogamic department in the herbarium of the Royal Gardens, Kew, England.

Dr. H. M. Fitzpatrick, assistant professor of plant pathology at Cornell University, visited the Garden several times recently to examine the collections. Dr. Fitzpatrick is spending three months at the Brooklyn Botanic Garden.

A large number of specimens of *Agaricus Rodmani* were found on May 19, 1915, by Mr. F. J. McCarthy in a partially shaded street border in Bedford Park, New York City, where this interesting double-ringed species was observed over ten years ago.

Mr. L. O. Overholts, who recently held a fellowship at the Missouri Botanical Garden, has been appointed instructor in botany at Pennsylvania State College. He enters upon his new duties on August 1.

Dr. F. D. Fromme, of Purdue University, formerly a student at the Garden, has accepted the position of plant pathologist and bacteriologist at the Agricultural Experiment Station, Blacksburg, Virginia.

Dr. H. S. Reed, until recently professor of plant pathology and bacteriology in the Virginia Polytechnic Institute, has been appointed professor of plant physiology in the Citrus Experiment Station and Graduate School of Tropical Agriculture, recently established by the University of California at Riverside.

Professor Edward M. Gilbert, of the University of Wisconsin, spent about a week at the Garden early in June studying the herbarium collection of tremellaceous fungi. He is planning to

devote considerable attention to this interesting, although somewhat neglected, group of basidiomycetes.

Dr. B. O. Dodge will spend six weeks during the summer at Camp Columbia, near Litchfield, Conn., where he will offer a course in general botany with special reference to the fungous diseases of forest trees. Some time will also be devoted to the collection and study of fleshy fungi. The work will be offered in connection with the Extension Teaching of Columbia University.

The March number of *The New Phytologist* contains an article by George K. Sutherland on marine fungi, a field of mycology which has been very poorly explored. The author of the paper restricts his investigations to those fungi which occur on *Pelvetia*. Four species of ascomycetes are recorded for this host, all of which are described as new. The number of species which occur on this host would suggest the possibility that marine fungi may be much more numerous than has previously been supposed.

In a recent number of the *Journal of Agricultural Research*, J. R. Weir records certain observations on *Rhizina inflata*. These observations tend to support the theory that this fungus is parasitic on coniferous seedlings. The roots of the dying seedlings were found to be covered with a mass of white mycelium which was found to be connected with the fruiting bodies of *Rhizina inflata*. One experiment was conducted which adds some experimental proof in support of the theory, although the experimental work is not extensive enough to be conclusive. The species has frequently been reported as a parasite in Europe.

The report of the state botanist of New York for 1913, prepared by Dr. Homer D. House, appeared early in June, 1915, as Bulletin 176 of the New York State Museum. It records the moving of the collections to the new building and their arrangement in the new metal herbarium cases in a way to make them more available for study and safer from insect attack. Three

new species of fungi are described, namely, *Inocybe euthelella* Peck, *Clitocybe phyllophiloides* Peck, and *Hebeloma palustre* Peck. Dr. House has contributed some very interesting notes on state local floras and an important article of over thirty pages with copious illustrations on certain features of German forestry.

In a recent professional paper on the pathology of the jack pine, James R. Weir states that the most important fungous disease of this tree is *Peridermium cerebrum,* the control of which in many localities is quite a serious forest problem. The most important wood-destroying fungi of the jack pine are *Trametes Pini* and *Polyporus Schweinitzii,* but these do not produce any appreciable decay until the tree reaches its period of decline, placed approximately at from sixty to eighty years of age. The wood of this tree deteriorates rapidly after it is cut under the influence of a number of saprophytic fungi and cannot be expected to remain sound in the forest for more than two or three years.

Dr. W. A. Murrill, Assistant Director, visited Washington, D. C., and Richmond, Va., early in June and found the chestnut canker abundant in the Washington parks and rapidly spreading south of the Potomac River. Most fleshy fungi were just beginning to appear in Virginia, having been delayed by the cool weather. *Pholiota praecox* and *Lentinus umbilicatus,* however, as well as *Polyporus arcularius,* were already abundant. Probably the most interesting species collected was *Bolbitius variicolor,* so well described and figured in Atkinson's "Studies of American Fungi." This was found in a shaded, manured yard in Falls Church, Virginia, on June 6. The pileus was olivaceous with yellowish center, reticulate-rugose, and very viscid; the lamellae at first straw-yellow or sulfur-yellow; the stipe pale-yellow above and white below, decorated with minute scales pointing upward.

RECENT SPECIFIC NAMES RECOMBINED

For the convenience of those using Saccardo's nomenclature, the names of species of boletes and polypores published in *My-*

cologia and in "Western Polypores" and "Tropical Polypores" in 1915 are recombined as follows:

ELFVINGIA BROWNII	= **Fomes Brownii**
INONOTUS LEEI	= **Polyporus Leei**
INONOTUS PORRECTUS	= **Polyporus porrectus**
PYROPOLYPORUS ABRAMSIANUS	= **Fomes Abramsianus**
ROSTKOVITES CALIFORNICUS	= **Boletus californicus**
TYROMYCES GRAMINICOLA	= **Polyporus graminicola**

W. A. MURRILL.

"Tropical Polypores," a book of 113 pages by W. A. Murrill, was issued June 15, 1915. It contains descriptions of the pileate species occurring in Mexico, Central America, southern Florida, the Bermudas, the West Indies, and other parts of tropical North America, together with descriptive notes and complete keys to the genera and species. *Tyromyces graminicola, Polyporus Marbleae,* and *Inonotus porrectus* are described as new; while *Inonotus leprosus* (Fries), *Fomes turbinatus* (Pat.), *Elfvingiella fasciata* (Sw.), *Fulvifomes calcitratus* (Berk. & Curt.) Murrill, *Fulvifomes Cedrelae* Murrill, *Fulvifomes cinchonensis* Murrill, *Fulvifomes dependens* Murrill, *Fulvifomes extensus* (Lév.) Murrill, *Fulvifomes grenadensis* Murrill, *Fulvifomes hydrophilus* Murrill, *Fulvifomes jamaicensis* Murrill, *Fulvifomes linteus* (Berk. & Curt.) Murrill, *Fulvifomes melleicinctus* Murrill, *Fulvifomes pseudosenex* Murrill, *Fulvifomes sarcitus* (Fries) Murrill, *Fulvifomes sublinteus* Murrill, *Fulvifomes subpectinatus* Murrill, *Fulvifomes Swieteniae* Murrill, *Fulvifomes troyanus* Murrill, *Fulvifomes Underwoodii* Murrill, and *Fulvifomes yucatanensis* Murrill are newly combined. The index to genera with species forms a handy check list and the authorities have been added for the convenience of those wishing to write labels.

THE NEW GENUS LENTODIELLUM

This genus was described for Volume 9, part 4, of *North American Flora,* but it had to be reserved for the following part which will not appear for some months.

27. LENTODIELLUM Murrill, gen. nov.

Persistent, fleshy-tough, densely cespitose; pileus smooth, deeply depressed; lamellae decurrent: spores hyaline: veil scanty, evanescent: stipe central, hard, woody.

Type species, *Panus concavus* Berk.

1. Lentodiellum concavum (Berk.) Murrill

Panus concavus Berk. Ann. Mag. Nat. Hist. II. 9: 194. 1852.

?*Lentinus cochleatus occidentalis* Fries, Nova Acta Soc. Sci. Upsal. III. 1: 227. 1855.

Pileus tough but fleshy, infundibuliform, densely cespitose, 3–8 cm. broad; surface glabrous but not polished, chalky-white, not striate, margin strongly incurved, appendiculate: lamellae strongly decurrent, crowded, narrow, white becoming yellowish: spores oblong-ellipsoid, pointed at one end, smooth, hyaline, $6–7 \times 2.5–3\,\mu$: stipe exannulate, central or nearly so, cylindric, connate below, glabrous or subglabrous, white, solid, tough, 4–8 cm. long, 3–4 mm. thick: veil thick, white, appendiculate.

TYPE LOCALITY: Santo Domingo.

HABITAT: On dead logs and stumps.

DISTRIBUTION: Tropical America.

W. A. MURRILL.

Dr. Arthur Harmount Graves, formerly assistant professor of botany in the Sheffield Scientific School of Yale University, returned early in July on the S. S. "St. Paul" from Liverpool. He has been spending a year in research at the laboratory of Professor V. H. Blackman, professor of plant physiology and pathology, Imperial Institute of Science and Technology, London. It may be recalled that Dr. Graves was one of a number of professors in the Sheffield Scientific School who were not reappointed in June, 1914, on account of a lack of funds.

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MYCOLOGIA

VOL. VII SEPTEMBER, 1915 NO. 5

ILLUSTRATIONS OF FUNGI—XXII

WILLIAM A. MURRILL

The accompanying figures were all drawn from specimens collected near Bronx Park, New York City. Many of the species figured are known to be edible. Dr. Kauffman has assisted me with *Cortinarius* and Dr. Burlingham with *Russula*.

Cortinarius roseipallidus sp. nov.

PALE-ROSY CORTINARIUS

Plate 163. Figure 1. $\times 1$

Pileus convex, becoming plane, solitary, about 7 cm. broad; surface smooth, hygrophanous, fibrillose-striatulate, rosy-isabelline, margin entire, pallid; context pale-rosy-isabelline, very thin; lamellae deeply sinuate, rounded behind, very broad, subdistant, fulvous; spores ellipsoid, smooth, subfulvous, $9\text{–}10 \times 6\,\mu$; stipe cylindric, rosy-isabelline, decorated with the remains of the fugacious veil, hollow, scarcely enlarged at the base, 5–7 cm. long, 1–1.5 cm. thick.

Type collected on the ground in deciduous woods east of the New York Botanical Garden, September 10, 1911, by W. A. Murrill. The pileus and stipe, as well as the context, are rosy-isabelline, or about the color of the back of a man's hand. This color is mostly concealed on the pileus by the hygrophanous character of the surface, but it is evident on the margin.

[MYCOLOGIA for July, 1915 (7: 163–220), was issued July 28, 1915.]

Melanoleuca Russula (Scop.) Murrill

Tricholoma Russula Gill.

REDDISH MELANOLEUCA

Plate 163. Figure 2. × 1

Pileus fleshy, convex, becoming plane or centrally depressed, obtuse, solitary or subcespitose, 7.5–12.5 cm. broad; surface viscid when moist, smooth or dotted with granular squamules on the disk, pale-pink or rose-red suffused at times with yellowish stains, margin usually paler, involute and minutely downy in the young plant; context white, sometimes tinged with red, the taste mild; lamellae subdistant, rounded behind or subdecurrent, white, often becoming red-spotted with age; spores ellipsoid, 6–7.5 × 4 μ; stipe solid, firm, dry, white, often reddish below, squamulose at the apex, 3–7 cm. long, 1.5–2.5 cm. thick.

This attractive plant, which resembles species of *Russula* but is firmer because the context is not vesiculose, is frequently found on the ground under oaks or in mixed woods in the northeastern United States. The specimen figured was collected near Bronx Park on August 6, 1911. I have seen other specimens with much redder surface. Peck includes the species in his list of edible mushrooms.

Gymnopilus farinaceus sp. nov.

MEALY GYMNOPILUS

Plate 163. Figure 3. × 1

Pileus convex to plane and at length upturned, solitary, 5 cm. broad; surface smooth, glabrous, somewhat hygrophanous, isabelline or pale-fulvous, fulvous on the disk; context white, thin, the taste decidedly sweet and farinaceous, the odor not characteristic; lamellae adnate to adnexed, rounded behind, very broad, subtriangular, purplish-brown, rather crowded; spores ellipsoid, smooth, ferruginous-melleous, 4–5 × 3–4 μ; stipe cylindric, equal, except at the expanded base, smooth, dry, glabrous, straw-colored, hollow, about 5 cm. long and 8 mm. thick.

Type collected on the ground in deciduous woods east of the New York Botanical Garden, September 10, 1911, by W. A. Murrill. The species seems near *Gymnopilus spumosus*. The pur-

plish-brown color of the lamellae should be noted, as well as the decidedly sweet, farinaceous taste of the context.

Cortinarius erythrinus Fries

BAY CORTINARIUS. UMBONATE CORTINARIUS

Plate 163. Figure 4. × 1

Pileus convex to expanded, becoming depressed about the conspicuous conic umbo, gregarious, reaching 3.5 cm. broad; surface smooth, polished, fuliginous; context extremely thin, dirty-whitish; lamellae slightly sinuate, very broad, crowded, fulvous; spores ellipsoid, smooth, fulvous, 8–9.5 × 4.5–5 μ; stipe slender, equal, grayish-white, solid, decorated with the fibrillose remains of the arachnoid, fugacious veil, about 3 cm. long and 3 mm. thick.

This species is well distinguished among the members of the genus *Cortinarius* in this region by its small size, prominent umbo, and dark-bay color, which often changes to blackish on drying. The specimens here figured were collected on the ground in deciduous woods east of the New York Botanical Garden, September 17, 1911.

Cortinarius anomalus Fries

ANOMALOUS CORTINARIUS

Plate 163. Figure 5. × 1

Pileus convex, not expanding, solitary or gregarious, 5–10 cm. broad; surface smooth, dry, subglabrous, pallid, tinged with dark-ochroleucous; context white, thick at the center and very thin at the edges; lamellae sinuate, broad, subcrowded, subfulvous; spores subglobose to ellipsoid, smooth, pale-ferruginous, 6–9 × 6–6.5 μ; stipe subconcolorous, almost white, enlarged at the base, solid, crooked, white within except at the base, smooth, dry, slightly fibrillose from the remains of the fugacious veil, about 5–6 cm. long and 7 mm. thick.

Collected in deciduous woods near Bronx Park, New York City, September 10, 1911. The plant suggests *Hebeloma* or *Flammula*. Those having access to exsiccati will find this species illustrated with excellent specimens prepared by Herpell. It is reported by the older mycologists from New England to North Carolina and west as far as Minnesota.

Russula crustosa Peck

CRUSTED RUSSULA

Plate 163. Figure 6. × 1

Pileus convex, becoming nearly plane or centrally depressed, 5–12 cm. broad; surface variable in color, stramineous, pale-ochraceous, brownish-ochraceous, greenish or greenish-yellow, rarely brownish-purple, usually dry, viscid when wet, with small, appressed, areolate scales, except on the smooth disk; margin striate when mature; context white, mild or slightly and tardily acrid; lamellae white, some short, some forked, narrowed toward the stipe, moderately close; spores white, subglobose, 8–10 μ; stipe white, equal, stuffed or hollow, 3–6 cm. long, 1.2–2.5 cm. thick.

This easily recognized species occurs rather commonly in mid-summer in woods or wood borders from Connecticut west to Michigan and south to Alabama and Mississippi. The specimen figured was collected near Bronx Park in August, 1911, and the taste was perfectly mild and agreeable. It is, however, sometimes slightly acrid when raw, but of excellent flavor when cooked. *Russula virescens*, a closely related species, is also edible.

Russula bifida (Bull.) Schröt.

Russula furcata (Lam.) Fries

FORKED RUSSULA

Plate 163. Figure 7. × 1

Pileus convex, becoming plane or concave, gregarious, 6–11 cm. broad; surface flavovirens, olivaceous, or some other shade of green tinged with fulvous or black on the disk, smooth or at times roughened with fine marks presenting a tomentose appearance which is deceiving; margin even, inflexed, the pellicle separable on the margin only; context white, mild in taste; lamellae white, forking twice or sometimes three times, adnate to slightly decurrent, rather broad, crowded to subdistant; spores globose, echinulate, hyaline, 7–9 μ; stipe white, tapering downward, solid, becoming spongy or hollow with age, smooth, 3–7 cm. long, 1–2 cm. thick.

This large and attractive species occurs rather commonly in the edges of oak woods about New York City during July and August.

I have always found it mild in flavor and therefore presumably edible, although a French chart includes it among the dangerous species. It should be thoroughly tested and carefully compared with related species before being used for food. Its large size, firmness, and comparative freedom from insect attack would make it desirable if perfectly harmless. Few species of *Russula* have these qualities, which are so important when considering mushrooms for food.

Lactaria Hibbardae Peck

HIBBARD'S LACTARIA

Plate 163. Figure 8. × 1

Pileus rather thin, broadly convex or nearly plane, slightly depressed, solitary or gregarious, 4–6 cm. broad; surface dry, fumosous, concentrically zonate, subglabrous; context very thin, firm, white; latex white, unchanging, decidedly acrid at once; lamellae adnate, rather narrow, subdistant, cream-colored; spores globose, roughly echinulate, hyaline, 7–9 μ; stipe equal, cylindric, smooth, glabrous, concolorous, about 3.5 cm. long and 1 cm. thick.

This species has been found a few times in Massachusetts and Vermont on the ground under coniferous trees, and I have collected it twice in the New York Botanical Garden under deciduous trees. In one case, the plants grew in considerable number on a lawn beneath a clump of oaks and maples. The authentic specimens of *L. Hibbardae* which I have seen appear to represent young stages only, and these agree perfectly with the young stages in my own collections. Some mycologists might possibly consider *L. Hibbardae* a small fumose variety of the common *L. ligniota,* but the color is decidedly distinct and shows no tendency to vary. The latex is white and acrid at once, but not so violent as that of *L. piperata,* for example.

Clavaria fusiformis Sow.

FUSIFORM CLAVARIA

Plate 163. Figure 9. × 1

Hymenophore densely clustered; clubs fusoid, rarely nearly cylindric, attenuate both at the apex and at the base, nearly erect,

simple, rather brittle but firm, soon hollow, smooth, glabrous, ochraceous to luteous, becoming somewhat darker at the apex with age; spores copious, ovoid, smooth, hyaline, $7–9 \times 5.5–6.5\ \mu$.

This pretty, yellow species grows in attractive clumps by roadsides in woods throughout the eastern United States and Europe. The plant is edible, with an excellent flavor, but is rarely found in sufficient quantity for food. The specimens figured are smaller than those usually seen.

Pholiota Johnsoniana (Peck) Sacc.

JOHNSON'S PHOLIOTA

Plate 163. Figure 10. $\times$ 1

Pileus soft, fleshy, convex to plane, gregarious, 6–8 cm. or more broad; surface smooth, moist, stramineous or cremeous to melleous-ochraceous, usually glabrous, rarely slightly squamulose, margin thin, pallid, striatulate at times when moist; context white, thick at the center, readily devoured by insects, the taste mild but not pleasant; lamellae adnate to adnexed, close, rather narrow, pale-purplish, becoming more fulvous as the spores mature; spores ovoid or ellipsoid, smooth, fulvous, $4.5 \times 3.5\ \mu$; stipe equal, cylindric, white to straw-yellow, solid, slightly striate at the apex, often floccose-scaly below the annulus, 5–12 cm. long, about 1 cm. thick; annulus median or situated slightly above the middle, thick, white, sometimes stellate below when young, persistent but rather easily broken.

Peck described and figured this species in 1872 from specimens collected by Hon. A. S. Johnson at Knowersville, New York, in September. Atkinson found it at Blowing Rock, North Carolina, and photographed some rather large specimens of it. I have collected it in the New York Botanical Garden several times in considerable quantity and Earle got it at Mt. Vernon, New York, a few miles north of here. The species appears in September or October, usually in woods or wood borders, and always on rich soil. It has somewhat the appearance of *Stropharia bilamellata,* but the lamellae, although purplish when young, are much lighter at maturity than in that species. The annulus is thick and sometimes stellate below in the young stages as in *Agaricus arvensis.*

NEW YORK BOTANICAL GARDEN.

UREDINALES OF PORTO RICO BASED ON COLLECTIONS BY F. L. STEVENS[1]

J. C. Arthur

(*Continued from page 196*)

36. Uromyces pianhyensis P. Henn. Hedwigia 47: 266. 1908.

On Carduaceae:

Wedelia reticulata DC., San German, Dec. 8, II, *4697*.

Although only uredinia are available in the Porto Rican material, yet they agree so exactly with the species described by Hennings from Brazil that no question of identity can be entertained. The type collection was made by E. Ule *3329*, in January, 1907, on an undetermined species of *Wedelia*. The portion of the leaf of the type collection, which has been examined, shows the same peculiar hairs along the veins, and in general has the same appearance, as the Stevens' collection, except that it is of a less firm texture, indicating a close relationship if not identity of host species.

The urediniospores may be described as globoid, or often triangular-obovoid, 18–21 μ in diameter, the light chestnut-brown wall closely and finely echinulate, thin, 1.5 μ or less thick, with pores indistinct, but probably 2 and equatorial.

37. **Puccinia Cameliae** (Mayor) comb. nov.

Uredo Cameliae Mayor, Mem. Soc. Neuchat. Sci. 5: 578. 1913.

On Poaceae:

Chaetochloa setosa (Sw.) Scribn. (*Setaria setosa* Beauv.), Mona Island, Dec. 20, 21, *6118*.

This collection shows both uredinia and telia. The species, showing only uredinia, was detected on a phanerogamic specimen in the herbarium of the New York Botanical Garden on

[1] Continued from Mycologia 7: 196. 1915.

C. scandens (Schrad.) Scribn. (*S. scandens* Schrad.) collected by Brisbane in Jamaica, Oct., 1896. Both the host of the latter specimen and that of the type of Mayor's *Uredo Cameliae* have been examined by Prof. A. S. Hitchcock, and the two pronounced identical.

Mayor's type collection was made at Camelia, a coffee plantation near Angelopolis, U. S. of Colombia. It has been possible, through the kindness of Prof. E. W. D. Holway, to examine some of the type collection. Most unexpectedly an abundance of telia were found, although they have not been mentioned by the author of the species. It is possible that they were overlooked, because they form small, inconspicuous sori, with spores so firmly pressed together, that the usual method of examination by scraping generally fails to discover them. They need to be studied by sectioning the leaf.

It is possible from type material to supply the following diagnosis:

Uredinia amphigenous, scattered, elliptical, small, 0.5 mm. long, rather tardily naked, cinnamon-brown; urediniospores ellipsoid, 15–21 by 19–28 μ; wall pale yellow to nearly colorless, thin, about 1 μ, closely and very finely echinulate, the pores obscure, 6–8, scattered.

Telia amphigenous, scattered, oblong or linear, 0.3–0.5 mm. long, blackish brown, long covered by the epidermis; teliospores firmly compacted together, oblong to cylindrical, small, 10–16 by 32–39 μ, truncate or rounded at both ends, or sometimes narrowed below, slightly or not constricted at the septum; wall chestnut-brown, thin, about 1 μ, darker and somewhat thicker above, 3–5 μ; pedicel very short, usually not seen.

38. PUCCINIA CENCHRI Diet. & Holw. Bot. Gaz. **24**: 28. 1897.

ON POACEAE:

Cenchrus echinatus L., Guanica, Feb. 3, *339;* Mona Island, Dec. 20, 21, *6277.*

Cenchrus viridis Spreng., Guanica, Feb. 1, *351;* Guayama, Dec. 4, *5338.*

The host of the collection from Mona Island was first pronounced by Prof. A. S. Hitchcock to be *C. viridis.* Upon learning from Dr. N. L. Britton that this host was not known from

Mona Island, although a specially thorough phanerogamic survey of the island has been made, the scanty material submitted by Dr. Stevens was gone over by Dr. Britton and Mr. Nash of the New York Botanical Garden, and again reviewed by Prof. Hitchcock. Prof. Hitchcock writes, Feb. 18, 1915: "I have reexamined it, and from the specimen itself I am inclined to think it may be *Cenchrus viridis,* but from the evidence which you present and the fragmentary condition of the specimen I think it best to let it stand as *Cenchrus echinatus.* The two species are closely allied, and one could not state with certainty from the fragmentary material that the specimen might not be a small fruited form of *Cenchrus echinatus.*"

The species has also been found in Cuba and in Bahamas on *C. echinatus,* by E. W. D. Holway.

39. PUCCINIA DEFORMATA Berk. & Curt. Jour. Linn. Soc. **10**: 357. 1869.

Dicaeoma deformatum Kuntze, Rev. Gen. 3^3: 468. 1898.

ON POACEAE:

Olyra latifolia L., San German, Dec. 12, *5849, 5855.*

The type collection was made by Charles Wright in Cuba, 1856–7. A Porto Rican collection was made by A. A. Heller at Mayagüez, Jan. 30, 1890, *4443.* Both are on *O. latifolia.*

40. PUCCINIA HUBERI P. Henn. Hedwigia Beibl. 39: 76. 1900.

ON POACEAE:

Panicum trichoides Sw., Villa Alba, Jan. 3, *82;* Maricao, Jan. 10, *194;* Nov. 18, *4810;* Adjuntas, Nov. 22, *4973;* Jayuya, Dec. 17, *5981;* all show uredinia only.

The only other Porto Rican collection seen is one by G. P. Clinton on the same host, obtained at La Carmelita, April, 1904.

The species was established on a collection by Dr. J. Huber on *Panicum ovalifolium* obtained in the Botanical Garden of Para, Brazil. It has not yet come to light in North America outside of Porto Rico.

41. PUCCINIA LEVIS (Sacc. & Bizz.) Magn. Ber. Deut. Bot. Ges. 9: 190. 1891.

Diorchidium leve Sacc. & Bizz. Michelia 2: 648. 1882.

Puccinia Paspali Tracy & Earle, Bull. Torrey Club 22: 174. 1895.

Dicaeoma Paspali Arth. Result. Sci. Congr. Bot. Vienne 344. 1906.

ON POACEAE:

Paspalum plicatulum Michx., Vega Baja, Feb. 20, II, *490*.

Rytilix granularis (L.) Skeels (*Manisuris granularis* Sw.), Rosario, Jan., 1914, *4835*.

No other collections are known from Porto Rico, but it was found in Antigua on *P. fimbricatum*, by J. N. Rose *3410*. Dr. P. Sydow kindly sent me material from his herbarium representing collections in *R. granularis* from Guadeloupe and Martinique.

A collecion of the rust on *P. pilosum* Lam. was obtained by Dr. Stevens at Caracas, Venezuela. It is a rather common rust in South America, and extends into North America as far as Texas and Louisiana. The type of the species was from Brazil on *Manisuris granularis*. A careful comparative study of the North American rust on *Paspalum*, called *P. Paspali* by Tracy and Earle, shows the two forms to be identical.

42. PUCCINIA SUBSTRIATA Ellis & Barth. Erythea 5: 47. 1897.

Uredo Chaetochloae Arth. Bull. Torrey Club 33: 518. 1906.

Puccinia Chaetochloae Arth. Bull. Torrey Club 34: 585. 1907.

ON POACEAE:

Paspalum Helleri Nash, Vega Baja, May 21, *1732*.

Paspalum orbiculatum Poir., Monte de Oro, Dec. 3, *5721*.

Paspalum paniculatum L., Mayagüez, Jan. 30, *293*; April 28, *898*; Monte Alegrillo, Nov. 14, *4758*.

The species was collected at Bayamon by E. W. D. Holway, Jan., 1911, on *P. Schreberianum* (Flügge) Nash, showing only uredinia.

Another West Indian collection was obtained by E. W. D. Holway in Cuba, March, 1903, on *Chaetochloa verticillata* (L.) Scribn. (*Setaria verticillata* Beauv.). A search in the phanero-

gamic herbarium at the N. Y. Bot. Garden revealed the following: from Cuba, on *C. imberbis* (Poir.) Scribn., J. A. Shafer *11795*, A. E. Jennings *154*, on *C. onurus* (Griseb.) S. & M., Norman Taylor *232*, Britton & Wilson *29*, on *C. setosa* (Sw.) Scribn., Rugel *880*; from Jamaica on *C. purpurascens* (H.B.K.) S. & M., N. L. Britton *1659*; and from Bermuda on *C. brevispica* S. & M., Stewardson Brown *116, 302*.

43. PUCCINIA CANALICULATA (Schw.) Lagerh. Tromsö Mus. Aarsh. **17**: 51. 1894.

Sphaeria canaliculata Schw. Trans. Am. Phil. Soc. II, **4**: 209. 1832.

Puccinia Cyperi Arth. Bot. Gaz. **16**: 266. 1891.

Uredo Kyllingiae P. Henn. Hedwigia **35**: 256. 1896.

Dicaeoma canaliculatum Kuntze, Rev. Gen. 3^3: 466. 1898.

ON CYPERACEAE:

Cyperus laevigatus L., Guanica, Feb. 3, *349*.

Cyperus radiatus Rottb., Mayagüez, Dec. 24, 1912, *147*, May 3, *1160*.

Cyperus sp., Villa Alba, Jan. 3, *114*.

The species has also been collected in Porto Rico on *C. cayennensis* (Lam.) Britt., at Mayagüez, by G. P. Clinton, April, 1904; on *C. sphacelatus* Rottb., at Mayagüez and La Carmelita, both by G. P. Clinton, April, 1904; on *C. polystachus* Rottb., at Cataruo, by A. A. Heller, May, 1899; and on *C. surnamensis* Rottb., at Añasco, by A. A. Heller, Feb., 1900. It was also found on a phanerogamic specimen of *Kyllinga pumila* Michx. (*K. caespitosa* Nees), in the phanerogamic herbarium at the New York Botanical Garden, collected by J. A. Stevenson, at Rio Piedras, Feb., 1914, *1274*, and on one collected by J. A. Shafer at Loma Icaco, July, 1914, *3452*.

Collections have also been made in Jamaica by L. M. Underwood, on *C. mutisii* H.B.K., Feb., 1903, *1526*, and by N. L. Britton, Sept., 1906, *14*; and it was detected on a phanerogamic specimen of *Kyllinga pumila* from Martinique, collected by Père Duss, Aug., 1903, *4714*.

44. PUCCINIA ELEOCHARIDIS Arth. Bull. Iowa State College 156. 1884.

Aecidium compositarum Eupatorii DeT.; Saccardo, Syll. Fung. 7: 798. 1888.

Dicaeoma Eleocharidis Kuntze, Rev. Gen. 3^3: 468. 1898.

ON CYPERACEAE:

Eleocharis cellulosa Torr., Santurce, May 21, *1792*.

Eleocharis geniculata (L.) R. Br., Mayagüez, March 9, *484*, *489*.

Eleocharis interstincta (Vahl) R. & S., Mayagüez, March 21, *416*.

Eleocharis sp., Cataño, Nov. 3, *4530*.

Porto Rican specimens of this rust have also been collected at Mayagüez, Feb., 1900, by A. A. Heller *4539*, and April, 1904, by G. P. Clinton, and also at Rio Piedras, Feb., 1912, by J. R. Johnston *201*. No other West Indian collections have been seen. All the collections cited show urediniospores only.

45. PUCCINIA FIMBRISTYLIDIS Arth. Bull. Torrey Club **33**: 28. 1906.

ON CYPERACEAE:

Fimbristylis diphylla Vahl, Ponce, Nov. 8, *4381*.

Fimbristylis ferruginea (L.) Vahl, Joyuda, March 31, *963*; Santurce, May 21, *1874*.

It has been collected on *Fimbristylis* sp., at Mayagüez, P. R., April, 1904, by G. P. Clinton, and on *F. diphylla*, at Asolen, Martinique, August 4, 1913, by Dr. F. L. Stevens *2970*. No other West Indian collections have been seen. All the collections here mentioned show only uredinia.

46. **Puccinia scleriicola** sp. nov.

Uredinia amphigenous, scattered, oval or oblong, small, 0.3–0.6 mm. long, rather tardily naked, cinnamon-brown, somewhat pulverulent, ruptured epidermis conspicuous; urediniospores broadly ellipsoid or obovoid, 15–22 by 19–26 μ; wall dark yellow, about 1.5 μ thick, finely and moderately echinulate, the pores 4, or sometimes 3, equatorial.

Telia chiefly hypophyllous, scattered, oval or oblong, small, 0.3–0.4 mm. long, tardily naked, blackish-brown; teliospores oblong or clavate-oblong, 15–19 by 29–42 μ, slightly constricted at the septum, truncate, oblique, or often rounded above, usually somewhat narrowed below; wall cinnamon-brown, 1.5–2 μ thick, usually thicker above, 3–6 μ, smooth; pedicel tinted, short.

ON CYPERACEAE:

Scleria sp., Preston's ranch near Naguabo, Dec. 31, II, *6684*.

It also occurs on specimens in the phanerogamic collection of the New York Botanical Garden on *Scleria hirtella* Sw., collected at Markin Pena, P. R., June, 1913, II, by J. R. Johnston *843*, and on *S. verticillata* Muhl., collected in Isle of Pines, Cuba, Dec., 1903, III, by A. H. Curtiss.

A number of localities are now known for the species in the United States. A collection was made on *S. hirtella*, at the edge of Long Prairie Hammock, on Camp Longview Trail, about forty miles southwest of Miami, Fla., Oct. 31, 1906, II and III, by Ernst A. Bessey. The following data have been secured from phanerogamic collections: in the Purdue University herbarium, on *S. Baldwinia* Torr., Everglades, Fla., June, 1877, II, A. P. Garber; N. Y. Bot. Garden herbarium, on *S. Baldwinia*, Everglades, Fla., March, 1892, II, J. H. Simpson *556*, on *S. pauciflora* Michx., Sumter Co., Ga., July, 1901, II, Roland M. Harper *1036*, on *S. setacea* Poir., Lee Co., Fla., July–August, 1900, II, A. S. Hitchcock *428*, Braidentown, Fla., Nov. 15, 1900, II and III, S. M. Tracy, on *S. verticillata* Muhl., Everglades, between Cutler and Longview Camp, Fla., Nov. 9–12, 1903, II and III, J. K. Small and J. J. Carter. This last collection is taken as the type of the species.

This species has much darker colored and thicker-walled urediniospores than *Rostrupia Scleriae* Paz., or *Puccinia xanthopoda* Syd. It also differs in its urediniospores from *Uromyces Scleriae* P. Henn., the latter having spores strongly thickened above.

47. PUCCINIA CANNAE (Wint.) P. Henn. Hedwigia **41**: 105. 1902.

Uredo Cannae Wint. Hedwigia **23**: 172. 1884.
Puccinia Thaliae Dietel, Hedwigia **38**: 250. 1899.

ON CANNACEAE:

Canna coccinea Ait. (*C. portoricensis* Bouché), Mamayes, May 21, 1912, II, *9*.

Canna glauca L., Cabo Rojo, Oct. 24, 1912, II, III, *169c*, Oct. 30, 1912, II, *169*.

Canna sp., Rio Piedras, June 2, 1912, II, *16;* Santurce, Jan. 3, 1912, II, *33;* Corozal, Feb. 21, II, *405;* Mayagüez, April, 1912, II, III, *4c*, April 30, II, *983;* Añasco, Oct. 19, *3595*, II, *3603;* Rosario, Nov. 14, II, *4834;* without locality or date, II, *157*.

ON MARANTACEAE:

Thalia geniculata L., Añasco, July 28, 1912, II, *66;* Mayagüez, July 29, 1912, II and III, *66c*.

The rust has also been collected on one of the two species of wild *Canna* known in Porto Rico by G. P. Clinton at Mayagüez, April 11, 1904, and on cultivated *Canna* at San Juan, April 8, 1904, and by J. A. Stevenson on Trujillo Alto road Nov., 1914, *2338*. It was also gathered on cultivated *Canna* at San Juan, by E. W. D. Holway, Jan., 1911. It was collected at Mayagüez, April, 1904, by G. P. Clinton on *Thalia geniculata*.

From other islands specimens have been seen collected by F. S. Earle in Jamaica on cultivated *Canna*, Oct.–Nov., 1902, *56*, and by both Mel. T. Cook, July 10, 1906, and C. F. Baker, July 2, 1906, in Cuba, on *Canna indica*. The last collection is issued in Sydow, Uredineen *2114*, and Bartholomew, Fungi Columbiani *2387*.

As usual with tropical rusts, the telia of this species are not abundantly produced. In the Stevens' set only four of the fourteen collections show telia. The telia, however, are in normal development. The collections of April and October, 1912, on *Canna*, were sent to Lafayette with the hope that they might be used in cultural work, but the teliospores could not be brought to germination, although every condition seemed favorable.

In comparing the collections on *Canna* and *Thalia*, there being two of each with both uredinia and telia, no difference could be found in the microscopic appearance of the fungus on the two hosts. The two hosts have essentially the same texture and structure of leaf. In both there is an epidermal layer of small,

rectangular cells, augmented by a hypodermal layer of very large, rectangular cells, the cells in both instances having unformly thin, but firm walls. The sori are situated below the hypodermal layer, often directly beneath a stoma. The resistance of the overlying tissue evidently accounts for the angular and irregular spores of both uredinia and telia.

The habitat for both *Canna* and *Thalia* is the same, and their manner of growth is similar. The two genera belong to closely related families, with many important characters in common. There are now many species of rusts known to go to more than one family of hosts. There seems no longer any good reason, either in the nature of the fungus or in the matter of convenience, for maintaining two specific names, and they are herewith united.

48. PUCCINIA MACROPODA Speg. An. Soc. Ci. Arg. **10**: 8. 1880.

Uredo striolata Speg. An. Soc. Ci. Arg. **9**: 173. 1880.

ON AMARANTACEAE:

Iresine elatior L. C. Rich., Desecheo, May 31, II, *1613*.

The same rust in its characteristic uredinial stage was collected on the same host on the island of St. Thomas, May, 1906, by C. Raunkiaer, and on *Iresine paniculata* (L.) Kuntze in Cuba, March, 1903, by E. W. D. Holway.

49. PUCCINIA RIVINAE (Berk. & Curt.) Speg. An. Mus. Buenos Aires **19**: 304. 1909.

Aecidium Rivinae Berk. & Curt. Jour. Linn. Soc. **10**: 358. 1869.
Endophyllum Rivinae Arth. N. Am. Flora **7**: 126. 1907.
Puccinia Raunkiaerii Ferd. & Winge, Bot. Tidsskr. **29**: 8. 1908.

ON PETIVERIACEAE (PHYTOLACCACEAE):

Rivina humilis L., Desecheo, May 31, I, II, *1590*.

Collections on the same host have been seen from Cuba, June, 1906, I, Mel. T. Cook, and from St. Thomas, Oct., 1906, I, II, III, C. Raunkiaer *1819*, also on *R. octandra* L. from Cuba, April, 1905, I, Baker & Van Herman *4775*.

50. PUCCINIA INFLATA Arth. Bull. Torrey Club 33: 516. 1906.

ON MALPIGHIACEAE:

Stigmaphyllon lingulatum (Poir.) Small (*Triopteris lingulata* Poir.), Desecheo, Jan. 2, O, II, III, *131*, May 31, O, II, III, *1578*, *1600;* Boqueron, Feb. 15, II, *328bis;* Guanica, Feb. 3, II, *334;* Coamo Springs, April 6, III, *818*, *850;* Mona Island, Dec. 20, 21, III, *6105*.

This species was collected in Porto Rico on the same host by E. W. D. Holway, at Ponce, Jan., 1911.

It has been collected in Cuba on *S. periplocifolium* (Desf.) Juss. by Mr. Holway, March, 1903 (Barth. N. Am. Ured. *42*), and by C. F. Baker, Oct., 1904, *3538*, and on *S. Sagraeanum* A. Juss. by Britton, Earle & Wilson, April, 1910, *6269*.

51. PUCCINIA EUPHORBIAE P. Henn. Engler's Bot. Jahrb. 17: 13. 1893.

ON EUPHORBIACEAE:

Aklema petiolaris (Sims) Millsp. (*Euphorbia petiolaris* Sims), Mona Island, Dec. 20, 21, *6185*.

The only other West Indian specimen of this species seen by the writer was collected on the same host in St. Thomas, March, 1913, by J. N. Rose *4510*.

52. PUCCINIA ARECHAVELATAE Speg. An. Soc. Ci. Arg. 12: 67. 1881.

ON SAPINDACEAE:

Cardiospermum microspermum H.B.K., Quebradillas, May 21, *1124;* Desecheo, May 31, *1628*, without locality or date, *1261*.

This common tropical rust was also collected on the same host by E. W. D. Holway at San Juan, Porto Rico, Jan., 1911. It was also collected on same host by A. S. Hitchcock (labeled *C. Halicacabum*), in Jamaica, Jan., 1891, and on phanerogamic specimens now in the N. Y. Bot. Garden herbarium, by J. A. Shafer *183* in Cuba, by Percy Wilson *8409* in Bahamas, and by Rose, Fitch & Russell *3333* in Antigua. The species was also collected on *C. grandiflorum* Sw. in Jamaica by L. M. Underwood, Sept., 1906.

53. PUCCINIA GOUANIAE Holw. Ann. Myc. 3: 21. 1905.

ON FRANGULACEAE (RHAMNACEAE):

Gouania lupuloides (L.) Urban (*G. domingensis* L.), Rosario, Feb. 16, II, iii, *322a;* Yauco, Oct. 3, II, *3134;* Cabo Rojo, Dec. 27, II, *6471.*

Gouania polygama (Jacq.) Urban (*G. tomentosa* Jacq.), Mayagüez, Feb. 3, II, iii, "*x*," May 4, II, *1209*, *1481*, May 24, II, *1705;* Rosario, Oct. 27, II, *3774;* Lares, Nov. 22, II, *4848;* Aguadilla, Nov. 25, II, *4857;* San German, Dec. 12, II, iii, *5860.*

The species has also been collected in Porto Rico by E. W. D. Holway at Mayagüez, Jan., 1911, on *G. lupuloides.*

The type collection was made at Gebara, Cuba, by Mr. Holway, March 1903, on *G. polygama* (Barth. N. Am. Ured. *544*). A collection made in Cuba by Charles Wright in 1856–7, represented in the Curtis Herbarium at Harvard University under the name "*Uredo gemmata* Berk & Curt.," belongs here. The host of this collection has recently been determined at the N. Y. Bot. Garden as *G. polygama.* Only uredinia are shown on it. I can not find that the name has been published. It is quite distinct from the collection in the same herbarium labeled "*Uredo gemmata* B. & C. var.," which belongs to *Uromyces gemmatus* Berk. & Curt. on *Jacquemontia nodiflora.* The rust occurs on a phanerogamic collection of *G. polygama* in the N. Y. Bot. Garden, collected at Herradura, Cuba, March 1907, by F. S. Earle *806.*

The only other collection of this rust known to the writer from the West Indies or elsewhere is one made on *G. lupuloides* in Panama, Oct., 1899, by G. von Lagerheim, showing both uredinia and telia. The packet is marked "rarissime!"

The urediniospores in collections "*x*" and *4857* appear to have three pores that are superequatorial. However, it is difficult to decide with certainty regarding the position of pores in but a small percentage of the spores of a mount, and it is impossible to say that this character is really distinctive. There appear to be no other characters, except possibly that the teliospores of "*x*" are somewhat larger than in *322a* and *5860*, which would separate these collections morphologically. The pore condition may eventually prove to be a variable character or possibly a racial character.

Puccinia gouaniicola Speg., on *Gouania latifolia* from Argentina, has teliospores of somewhat similar shape and size but with clear golden-yellow walls, and fragile pedicels. The sori are large and cushion-shaped, and unaccompanied by urediniospores. The species appears to be a leptopuccinia, and not yet represented in North America. I am indebted to Dr. Spegazzini for a portion of the type collection of *P. gouaniicola*.

54. PUCCINIA HETEROSPORA Berk. & Curt. Jour. Linn. Soc. **10**: 356. 1869.

Uromyces pulcherrimus Berk. & Curt. Grevillea **3**: 56. 1874.
Uromyces Thwaitesii Berk. & Br. Jour. Linn. Soc. **14**: 130. 1875.
Uromyces Sidae Thüm. Rev. Mycol. **1**: 10. 1879.
Uromyces pictus Thüm. Rev. Mycol. **1**: 10. 1879.
Uromyces malvacearum Speg. An. Soc. Ci. Arg. **12**: 71. 1881.
Puccinia Thwaitesii Winter, Hedwigia **22**: 130. 1883.
Uromyces malvicola Speg. An. Soc. Ci. Arg. **17**: 94. 1884.
Dicaeoma pulcherrimum Kuntze, Rev. Gen. 3^3: 467. 1898.

ON MALVACEAE:

Abutilon hirtum (Lam.) Sweet., Guanica, Feb. 3, *330*, Feb. 10, *343*.

Sida glutinosa Comm. (*S. nervosa* DC.), Villa Alba, Jan. 3, *106*.

Sida humilis Cav., Boqueron, Feb. 15, *330bis*.

Sida procumbens Sw., Guanica, Feb. 3, *322;* Desecheo. May 31, *1583*.

Sida spinosa L., Guayama, Dec. 4, *5331*.

Sida urens L., Guayamilla, Nov. 13, *5870;* Coama Springs, Jan. 1, *59;* Vega Baja, Feb. 22, *383;* Yauco, Oct. 3, *3133, 3249;* Maricao, Oct. 8, *3449;* Rosario, Oct. 27, *3790, 3835*, Nov. 14, *4846;* Vega Alto, Nov. 19, *4145;* Ponce, Nov. 8, *4274;* Mayagüez, Nov. 13, *4716a*, Jan. 14, 1914, *6784;* Aguada, Nov. 22, *5108;* El Gigante near Adjuntas, Dec. 15, *5821*.

Wissadula periplocifolia (L.) Presl (*Abutilon periplocifolium* G. Don), Coamo Springs, Jan. 1, *271;* Guanica, Feb. 3, *329*.

The species was also collected at Ponce, on *Sida* sp., by E. W. D. Holway, Jan., 1911; at Vieques Island on *Sida humilis,* by J. A. Shafer, Jan., 1914, *2504A;* and at Rio Piedras on *Sida urens,* by J. A. Stevenson *2453*. It also occurs on a phanerogamic specimen of *Wissadula periplocifolia* in the herbarium of the N. Y. Bot. Garden, collected at Yauco by Underwood & Griggs *625*, June–July, 1901.

The species, which is very common in warmer regions, is also represented in the writer's herbarium from Bahamas, Cuba, Jamaica, St. Croix, and St. Thomas.

55. PUCCINIA PSIDII Wint. Hedwigia **23**: 177. 1884.

Uredo flavidula Wint. Hedwigia **24**: 260. 1885.
Uredo Myrtacearum Paz. Hedwigia **29**: 159. 1890.
Uredo Eugeniarum P. Henn. Hedwigia **34**: 337. 1895.
Puccinia Jambosae P. Henn. Hedwigia **41**: 105. 1902.

ON MYRTACEAE:

Jambos Jambos (L.) Lyons (*Eugenia Jambos* L.), Consumo, April 27, II, *886*, Oct. 23, 1912, II and III, *63c;* Maricao, without date, II, *159*, Oct. 12, II and III, *182*, April 2, II, *429*, April 3, II and III, *710*, II, *720;* Rio Maricao above Maricao, Sept. 30, II, *3626*, Sept. 20, II and III, *3652;* Barros, Jan. 2, II and III, *208;* Villa Alba, Jan. 3, II and III, *528;* Monte de Oro near Cayey, Dec. 3, II, *5719;* Lajome Alto, Dec. 3, II, *5759;* El Gigante near Adjuntas, Dec. 15, *6017*.

Psidium Guajava L., Villa Alba, Jan. 3, II, *108*.

The rust has also been collected at the base of El Yunque, Cuba, March, 1903, by E. W. D. Holway and by Underwood & Earle. No other North American collections are known to the writer.

The ample collections secured by Dr. Stevens have made it possible to get so good an understanding of the species and its hosts, that the synonymy can now be adjusted. Urediniospores of the five species, as named above, have been examined, and found to agree perfectly. Type material of *Uredo flavidula,* as

distributed in Rab.-Winter, Fungi Europaei *3312,* has been studied as well as type material of *Uredo Eugeniarum.* Authenticated material of *Uredo Myrtacearum,* distributed in Sydow, Uredineen *2100,* and of *Puccinia Jambosae,* have also been examined. They appear to be identical in their urediniospores, and the teliospores of the last mentioned agree exactly with those in the Stevens' collections on the same host. The original descriptions, establishing the five names above, agree in all essentials where they touch upon the same characters. There are no known species of *Uromyces* on hosts belonging to the *Myrtaceae,* and therefore a possible complication is removed.

In Sydow's Monog. Ured. **1**: 437, Spegazzini's species *Uredo subneurophyla* (Anal. Soc. Ci. Agr. **17**: 123. 1884), which is on a species of *Psidium* from Paraguay, is listed as a synonym of *Puccinia Psidii.* I have studied a part of the type collection of *U. subneurophyla* and find that it does not agree with this species, and in fact does not belong to the *Uredinales,* being a fungus quite unlike a rust. I have seen no material of Spegazzini's *Uredo neurophyla,* published on the preceding page of the same work. This species is said to be on leaves of *Myrtaceae,* and to greatly differ from his *U. subneurophyla.* So far as one can judge from the most inadequate description, it may well be a synonym of *P. Psidii.*

Two other species of rusts are recorded as inhabiting Myrtaceous hosts. *Puccinia sanguinolenta* P. Henn., said to be on *Myrcia,* is really on the Malpighiaceous host, *Heteropteryx,* as pointed out by Holway, N. Am. Ured. **1**: 59. 1907. Material of *Puccinia Rompelii* Magn., said to be on *Myrtaceae,* proves to be a distinctive species, quite unlike the above.

56. **Puccinia concrescens** Ellis & Everhart sp. nov.

Puccinia compacta Kunze; Bubák, Hedwigia Beibl. **42**: 30. 1903. Not Berk. 1855, DeBary 1858, or Thüm. 1875.

ON ASCLEPIADACEAE:

Asclepias curassavica L., Vega Baja, Feb. 20, *485,* March, *517;* Aibonito, June 5, *2139;* Manati, Nov. 25, *5310, 5311;* Jajome Alto, Dec. 3, *5645.*

The species was also collected in Porto Rico on the same host by Mr. and Mrs. A. A. Heller in 1899, *863*, as noted below, and by E. W. D. Holway, above Comercio, Feb., 1911.

It was also found in the phanerogamic collection at the New York Botanical Garden on the same host collected by A. H. Curtiss near Nassau, Bahamas, Dec., 1902, *2*, by Britton & Millspaugh at Eight Mile Rocks, Great Bahama, Feb., 1905, *2428*, and by Pollard & Palmer at Baracoa, Cuba, Jan., 1902, *11*.

It was pointed out by Bubák in 1901 (Sitz, Böhm. Ges. Wiss., page 5 of separate) that the earliest use of the name, *Puccinia compacta*, was for some species quite unlike the Ranunculaceous rust, for which DeBary's name had then come into use. It appears that Kunze gave the name to a collection from Surinam, made by Weigelt in 1827. Thümen remarks in Flora (1875, p. 364) that "the fungus from Surinam is highly characteristic, and I here give a diagnosis drawn from an original specimen, as none is known to me." Thümen's diagnosis and appended comments show that the specimen he had in hand was one collected in Surinam by Weigelt on an undetermined host, which we now know to be *Dasyspora foveolata* Berk. & Curt. on *Xylopia* sp. This was the same collection that Kunze had intended to name *Puccinia gregaria*. Hennings tells us in Hedwigia (1896, p. 230) that he found a specimen in the Berlin herbarium collected by Weigelt in Surinam, 1827, bearing the name *P. gregaria* Kunze and with a Latin diagnosis appended, which he publishes. The herbarium name of *P. compacta*, given by Kunze to a collection by Weigelt in Surinam on some Asclepiadaceous plant (now known to be *Asclepias curassavica*), was first published by Bubák in 1903, accompanied with a description and figures.

In the Ellis herbarium, now at the New York Botanical Garden, is a specimen of rust from Porto Rico, inscribed *Puccinia concrescens* E. & E., accompanied by a diagnosis in Mr. Ellis' handwriting. This name, as I have previously stated (Jour. Myc. **11**: 10. 1905), appears not to have been published. In the absence of a usuable name, the one given by Ellis may be brought forward, and it is here presented with Ellis' description slightly modified.

Telia hypophyllous, in orbicular groups on discolored spots, pulvinate, crowded but distinct, becoming confluent at the center into a cushion-like mass 2–4 mm. across, chestnut-brown, often darker at the center of the groups and paler at the edges; teliospores oblong-elliptical; often irregular, 12–20 by 20–40 μ, rounded or obtuse at both ends, or oftener somewhat narrowed below, slightly or not constricted at septum, which is occasionally oblique; wall chestnut-brown or paler, smooth, uniformly thick, 1.5–2 μ, or slightly thicker above in some spores; pedicel as long or longer than the spore, but usually appearing short by being broken away.—On *Asclepias curassavica* L., Aibonito, Porto Rico, March 22, 1899. Mr. & Mrs. A. A. Heller *863*, host no. *862*.

A part of this type collection was sent to Dr. Bubák in 1903, and was pronounced by him to be identical with the Weigelt collection from Surinam. He sent in return a portion of the Weigelt collection obtained from the botanical division of the Bohemian Museum in Prag, which fully substantiated his statement.

57. PUCCINA OBLIQUA Berk. & Curt. Jour. Linn. Soc. **10**: 356. 1858.

Puccinia Cynanchi Lagerh. Bol. Soc. Brot. **7**: 129. 1889.

Puccinia sphaerospora Syd. & Henn. Ann. Myc. **1**: 327. 1903.

ON ASCLEPIADACEAE:

Metastelma lineare Bello, Barros, Jan. 2, *132*.

Metastelma parviflorum R. Br., Vega Baja, Feb. 22, *368;* Quebradillas, Nov. 22, *5023*.

Other West Indian collections have been made on *M. parviflorum* in St. Thomas, March, 1913, by J. N. Rose *4509*, and on *M. Schlechtendahlii* DC. in St. Croix, Dec., 1895, by A. E. Ricksecker, and in St. Thomas, March, 1913, by J. N. Rose. The type collection for the name *P. Cynanchi* Lag. is recorded for Martinique on *M. parviflorum*, but has not been examined. The species also occurs on phanerogamic specimens in the N. Y. Bot. Garden on *Fischeria crispiflora* (Sw.) Schl. from Isle of Pines, Cuba, May, 1910, O. E. Jennings *439*, and from Jamaica, Feb., 1906, A. E. Wight *150*.

Through the kindness of the Director of the Kew Herbarium I have been enabled to examine a part of the type material of

Puccinia obliqua Berk. & Curt., collected in Cuba, by Charles Wright. The material consists of a complete leaf, the blade of which is ovate, four by eight millimeters, entire and smooth, with a petiole five millimeters long. The under surface of blade and petiole is quite evenly covered with about eighty pulvinate, prominent, brown sori. Both gross and microscopic appearance of the fungus that has of recent years been assigned to *Puccinia sphaerospora* S. & H. agree with this specimen. The host is undoubtedly some Asclepiadaceous plant, probably a *Vincetoxicum* or *Philibertia*.

The closely related species, *Puccinia Gonolobi* Rav., has been collected in the Bahamas on *Metastelma palustre* (Pursh) Schl., Aug., 1904, E. G. Britton *396*, Jan., 1903, and March, 1905, A. E. Wight, on *Philibertella clausa* (Jacq.) Vail, Feb., 1905, E. G. Britton *3423*, and in Cuba on the last host, March, 1910, Britton, Earle & Wilson *6022*.

58. PUCCINIA CRASSIPES Berk. & Curt. Grevillea **3**: 54. 1874.

Puccinia Ipomoeae Cooke; Lagerh. Tromsö Mus. Aarsh. **17**: 61. 1895.

ON CONVOLVULACEAE:

Ipomoea triloba L., Mona Island, Dec. 20, 21, *6086, 6236, 6239*.

The collections show both aecia and telia in good condition, as also does a collection from Santa Ysabel, P. R., J. R. Johnston *203*, Jan., 1912.

Collections have been seen also from St. Croix, on *I. triloba*, and from Cuba, on *I. acuminata* (Vahl) R. & S. (*I. cathartica* Poir.) by Earle & Wilson *1140* (Barth. Fungi Columb. *2456*), and on *I. trichocarpa* Ell. (*I. carolina* Pursh not L.) by Britton, Earle & Wilson *4827*.

59. PUCCINIA LANTANAE Farl. Proc. Amer. Acad. Sci. **18**: 83. 1883.

ON VERBENACEAE:

Lantana Camara L., Guanica, Feb. 3, *358*, Dec. 29, *6607;* Lares, Nov. 22, *4926;* Guayanilla, Nov. 13, *5952*, Dec. 29, *6603*.

Lantana involucrata L. (*L. odorata* L.), Boqueron, Feb. 15, *354;* Arecibo, May 21, *1781;* Quebradillas, Nov. 22, *5017;* San German, Dec. 8, *5763;* Mona Island, Dec. 20, 21, *6440;* without locality, Jan. 17, 1914, *6823*.

This species has not before been seen by the writer from Porto Rico. It has often been collected in other West Indian islands, however. In Cuba it was found on *L. Camara,* March, 1903, E. W. D. Holway (Barth, N. Am. Ured. *645*), Sept., 1906, L. M. Underwood *3248;* on *L. involucrata,* May, 1906, C. F. Baker *2869,* and on a phanerogamic specimen in the N. Y. Bot. Garden on *L. trifolia* L., April, 1902, S. H. Hamilton *46*. In Jamaica it was found on *L. crocea* Jacq., Sept., 1906, N. L. Britton *35*, and on a phanerogamic specimen in the N. Y. Bot. Garden on *L. stricta* Sw., Sept., 1906, N. L. Britton *7*. In the Bermudas it was collected on *L. involucrata,* Nov.–Dec., 1912, Brown, Britton & Seaver *1301*, and in St. Thomas on *L. aculeata* L., March, 1913, J. N. Rose.

60. PUCCINIA URBANIANA P. Henn. Hedwigia 37:278. 1898.

ON VERBENACEAE:

Valerianodes jamaicensis (L.) Medic. (*Abena jamaicensis* Hitchc., *Stachytarpheta jamaicensis* Vahl), Santurce, June 12, 1912, *64*, Jan. 16, *241;* Vega Baja, Nov. 5, *4232;* Manati, Nov. 25, *4900, 5280;* Guayama, Oct. 4, *5554;* River junction below Utuado, Dec. 16, *6038*.

Valerianodes strigosa (Vahl) Kuntze (*Stachytarpheta strigosa* Vahl), Cabo Rojo, June 15, *2285;* Mona Island, Dec. 20, 21, *6252, 6279*.

Porto Rican collections on *V. jamaicensis* have also been made at San Juan, May, 1903, F. S. Earle, and Feb., 1911, E. W. D. Holway; at Mayagüez, April, 1904, G. P. Clinton; and at Rio Piedras, Feb., 1913, J. R. Johnston *946*.

Other West Indian collections have been made in Cuba, March, 1906, by C. F. Baker *830*, in Jamaica, Oct.–Nov., 1902, by F. S. Earle *204*, Jan., 1903, by L. M. Underwood, Feb., 1913, by E. W. D. Holway *216*, and in the Bahamas, Nov., 1890, by A. S. Hitchcock, and March, 1903, by E. W. D. Holway (Barth. N. Am. Ured. *669*).

61. **Puccinia Leonotidis** (P. Henn.) comb. nov.

Uredo Leonotidis P. Henn. in Engler, Pfl. Ost.-Afr. **C**: 52. June, 1895.

Aecidium Leonotidis P. Henn. in Engler, Pfl. Ost.-Afr. **C**: 52. June, 1895.

Uredo cancerina P. Henn. Hedwigia 34: 330. December, 1895.

Uredo leonoticola P. Henn. Hedwigia 38: 69. 1899.

Puccinia leonotidicola P. Henn. in Baum, Kun.-Samb. Exp. 1903.

ON LAMIACEAE (LABIATAE):

Leonotis nepetaefolia (L.) R. Br., Yabucoa, May 17, 1912, *4;* Coamo Springs, Jan. 1, *127*, April 6, *845*; Hormigueros, Jan. 14, *216*; Bayamon, Feb. 14, *390*; Lares, Nov. 22, *4836*, *4916*; Guayama, Dec. 4, *5336*; Ponce, Dec. 4, *5394;* Guayanilla, Nov. 13, *5869*.

The West Indian collections examined are from Ponce, P. R., Jan., 1911, E. W. D. Holway; Rio Piedras, P. R., 1912, J. R. Johnston, *454*, *498*, between Aibonito and Cayey, P. R., Feb., 1899, A. A. Heller *557;* Kingston, Jamaica, Oct., 1899, G. Lagerheim, and July, 1910, Eug. Mayor *119;* Port Antonio, Jamaica, Feb., 1915, E. W. D. Holway; Havana, Cuba, March, 1903, E. W. D. Holway (Barth. N. Am. Ured. *781*); Nassau, Bahamas, June, 1909, P. Wilson *8437*.

So far no American collection has revealed other than urediniospores. These are characteristic in being somewhat flattened from above, with the wall slightly thicker in the upper part, and in having three to five, usually four, basal pores close to the hilum. A collection by Lagerheim from Jamaica bears the inscription "*Uredo basipora* Lagerh. n. sp.," which indicates that the peculiar arrangement of pores was seen by Lagerheim, but I do not find that he published his proposed name.

The assignment of the species to the genus *Puccinia,* is based upon observations by Hennings, who published a description ot teliospores, taken from South African material. In my herbarium is a part of the same collection, made April 18, 1900, by the Kunene-Zambesi Expedition, one half of a well rusted leaf, but it shows no teliospores, although there is an abundance of

characteristic urediniospores. A portion of the type material of *Uredo cancerina* and *U. leonoticola* has been examined. The species as here indicated seems consistent with other species on related hosts in its morphology, and with tropical forms generally in rarely producing other than repeating spores.

62. PUCCINIA MEDELLINENSIS Mayor, Mem. Soc. Neuch. Sci. 5:497. 1913.

Aecidium Hyptidis P. Henn. Hedwigia 34:337. 1895.

Eriosporangium tucumanense Arth. (in part) N. Am. Flora 7:212. 1912.

ON LAMIACEAE (LABIATAE):

Mesosphaerum atrorubens (Poir.) Kuntze (*Hyptis atrorubens* Poir.), Santurce, Jan. 22, *255*.

Mesosphaerum pectinatum (Poir.) Kuntze (*Hyptis pectinata* Poir.) Villa Alba, Jan. 3, III, *49;* Coamo Springs, Jan. 1, I, *152;* Corozal, Feb. 21, II, *413;* Mayagüez, April 30, II, *938,* May 1, II, *1065;* Rosario, Oct. 27, II, *3834;* Lares, Nov. 22, I, II, II, *4921;* Cabo Rojo, Dec. 27, II, *6486*.

Mesosphaerum suaveolens (L.) Kuntze (*Hyptis suaveolens* Poir.), Mayagüez, April 15, *882*, Oct. 31, *3892;* Ponce, Nov. 11, *4275;* Aguada, Nov. 22, *4913;* Guayama, Dec. 4, *5397;* Guayanilla, Nov. 13, *5867*.

Other West Indian collections of this species on *M. pectinatum* are from La Carmelita, P. R., April, 1904, O, I, II, III, G. P. Clinton, *128*, Aibonito, P. R., Feb. 1911, II, III, E. W. D. Holway, Mandeville and Kingston, Jamaica, Feb., 1915, E. W. D. Holway, *224*, *232*.

Collections of urediniospores on *M. suaveolens* have also been made at Constance Springs, Jamaica, Dec., 1910, by A. S. Hitchcock, and at Santiago, Cuba, March, 1903, by E. W. D. Holway.

The form on *M. pectinatum* reported in the North American Flora was confused with the South American form on *M. spicatum,* which until the present time has only been described under the name of *Aecidium tucumanense* Speg. Type material of the latter, however, shows uredinia and telia sparingly among the aecia. The spore-forms are all somewhat larger than those of

the form on *M. pectinatum,* the teliospores measuring about the same length, but half as much wider. The South American species should be called **Puccinia tucumanensis** (Speg.) comb. nov.

Type material of *P. medellinensis* agrees perfectly with the Stevens' collections on *M. pectinatum,* and also with the collections cited in the North American Flora on page 213 of volume 7. Type material of *Aecid. Hyptidis* P. Henn. also agrees with this species in morphological characters, and the host appears to be *M. pectinatum,* as well as one can tell from a few leaves.

All collections so far seen on *M. atrorubens* and *M. suaveolens* show only urediniospores. The teliospores of *P. Hyptidis* and *P. medellinensis,* as well as *P. tucumanensis* are readily told apart, but the urediniospores of these species all have two equatorial pores, and otherwise are too much alike to be distinguished with certainty when taken by themselves. So far as any differences exist, and especially in the large proportion of urediniospores with the vertical axis shorter than the transverse axis, they indicate that the forms can best be placed here.

63. PUCCINIA HYPTIDIS (M. A. Curt.) Tracy & Earle, Bull. Miss. Exp. Sta. **34**:86. 1895.

Eriosporangium Hyptidis (Curt.) Arth. N. Am. Flora **7**:211. 1912.

ON LAMIACEAE (LABIATAE):

Mesosphaerum capitatum (L.) Kuntze (*Hyptis capitata* Jacq.), Mayagüez, Jan. 7, *57*, Jan. 30, *305*, Jan. 28, *374;* Villa Alba, Jan. 3, *105*, *136*, *149;* Coamo Springs, Jan. 1, *100;* Vega Baja, Feb. 20, *471;* Añasco, Oct. 12, *3526;* Rosario, Oct. 27, *3826*, Nov. 14, *4841;* Quebradillas, Nov. 22, *5166;* Monte de Oro near Cayey, Dec. 13, *5707;* Lares, Nov. 22, *5932;* El Gigante near Adjuntas, Dec. 15, *6023*.

The above numbers show only uredinia, and the assignment to *Puccinia Hyptidis* is somewhat uncertain. The size of the urediniospores, thickness of wall, echinulation, pore-arrangement, and the rarity of flattened spores in which the vertical diameter is less than the transverse, are all characters that agree with those of

the urediniospores of *P. Hyptidis*. Until teliospores are discovered, the form is most conveniently left here.

Collections of uredinia on the same host have also been made in Porto Rico at Bayamon, Jan., 1911, in Cuba at Baracoa, March, 1903, and in Jamaica at Port Antonio, Feb., 1915, all by E. W. D. Holway.

64. **Puccinia insititia** sp. nov.

ON LAMIACEAE (LABIATAE):

Mesosphaerum latanifolium (Poir.) Kuntze (*Hyptis latanifolia* Poir.), Aibonito, June 5, *2133*.

A small amount of material was found, showing urediniospores only. These spores are quite unlike other American rusts on this genus of hosts so far seen by the writer, especially in having three equatorial pores. The specimen seems identical, so far as it goes, with a collection on the same host from Manos in the Amazon region of Brazil, collected by E. Ule in 1901, and distributed under the name of *Aecidium Hyptidis* P. Henn. The Brazilian material shows urediniospores and a few teliospores. Many of the uredinia simulate aecia in gross appearance by the ruptured epidermis becoming white like a peridium, and somewhat in the microscopic appearance by the fine, close sculpturing of the spores. There are no aecia present on the specimen in hand, and probably the name was given from the aecia-like uredinia. On the strength of this Brazilian collection, which is made the type as it is represented in the herbarium of the New York Botanical Garden, the form is here established as a species under the above name, with the following description:

Uredinia hypophyllous, scattered, round, 0.3–0.6 mm. across, rather early naked, encircling epidermis evident, often white and peridioid, urediniospores globoid or broadly ellipsoid, 20–25 by 23–28 μ; wall cinnamon-brown, thin, 1–1.5 μ, densely and finely echinulate-verrucose, the pores 3, equatorial, often indistinct.

Teliospores narrowly ellipsoid, 16–24 by 48–55 μ, rounded or obtuse above, rounded or narrowed below, slightly or not constricted at septum; wall colorless, thin, 1 μ or less, smooth; pedicel colorless, delicate, about half length of spore.

65. PUCCINIA SALVIICOLA Diet. & Holw. Bot. Gaz. 24: 33. 1897.

ON LAMIACEAE (LABIATAE):

Salvia occidentalis Sw., Mayagüez, Jan. 15, *285*, April 17, *526*; Corozal, Feb. 21, *407*; Aguada, Nov. 22, *5088*.

The rust has also been found on the same host in Porto Rico at Caguas, 1899, Mr. & Mrs. A. A. Heller *941*, at La Carmelita, April, 1904, G. P. Clinton, and at Ponce, Feb., 1911, E. W. D. Holway. All Porto Rican specimens so far seen show only uredinia. There is a close resemblance between the uredinia of this species and those of *Puccinia medellinensis*, but the teliospores are very unlike. A collection on the same host, made in Jamaica on Mt. Diabolo, 2000 feet altitude, April, 1903, by L. M. Underwood *1802*, shows a few telia on the stems, well supplied with characteristic teliospores, and with uredinia on the leaves, which clearly establishes the species for this host in the West Indies. It was collected, showing uredinia only, at Port Antonio, Jamaica, Feb., 1915, by E. W. D. Holway *220*, on the same host.

66. PUCCINIA BLECHI Lagerh. Bull. Soc. Myc. Fr. 11: 214. 1895.

Uredo balaensis Syd. Ann. Myc. 1: 21. 1903.

ON ACANTHACEAE:

Blechum Brownei (Sw.) Juss., Mayagüez, April 16, *525*.

The two names cited above appear to belong to the same rust as the one collected by Stevens in Porto Rico, although type material has not been examined. The rust on the same host has also been found in Guatemala, Jan., 1906, W. A. Kellerman *5400*.

67. PUCCINIA LATERITIA Berk. & Curt. Jour. Phila. Acad. Sci. 2: 281. 1853.

ON RUBIACEAE:

Borreria levis (Lam.) Griseb., Vega Baja, Feb. 20, *474*; Cabo Rojo, Sept. 28, *3187*; Coamo Springs, Jan. 1, *141*; San Sebastian, Nov. 22, *5186*.

Borreria verticillata (L.) G. F. W. Mey., without locality, June 12, 1912, *31*; Mayagüez, July 12, 1912, *45*, Jan. 12, *21*, Jan. 15, *288*; Boqueron, Feb. 15, *347*; Bayamon, May 21, *1886*; Indura Fria, Maricao, Oct. 8, *3461*;

Cataño, Nov. 6, *4191;* Utuado, Nov. 8, *4416, 4581a;* Lares, Nov. 22, *4846bis;* Quebradillas, Nov. 22, *5014;* Aguada, Nov. 22, *5103.*

Diodia maritima Thonn., Mayagüez, Feb. 8, *284a, 289.*

Diodia rigida C. & S., Manati, May 11, *4243a;* Rio Piedras, Nov., *5727.*

Ernodea littoralis Sw., Boqueron, Feb. 15, *348;* Mona Island, Dec. 20, 21, *606F, 6058.*

Mitracarpus portoricensis Urban, Guanica, Dec. 29, *6827.*

Spermacoce tenuior (L.) Lam., Hormigueros, Jan. 14, *213, 713;* Guanica, Feb. 3, *323;* Coamo Springs, April 6, *846;* Cabo Rojo, June 15, *2266;* San German, Nov. 8, *5813, 5816.*

This common, short cyle rust of warm regions has also been found in Porto Rico on *B. laevis* at Mayagüez, April, 1904, G. P. Clinton, and at Rio Piedras, June, 1912, J. R. Johnston *457,* on *B. verticillata,* between Caguas and Cayey, June, July, 1901, Underwood & Griggs *295a,* at Rio Piedras, June, 1914, J. A. Stevenson *2013,* on *D. maritima,* at Mayagüez, April, 1904, G. P. Clinton *170,* Cataño, Feb., 1914, J. R. Johnston *1364,* and on *S. tenuior* at Campo Alegre, Dec., 1914, J. A. Stevenson *2459.*

From other West Indian islands it has been gathered on *B. laevis* in Jamaica, L. M. Underwood, Jan. 1903, *83,* March, 1903, *1736,* on *E. littoralis* in New Providence, Bahamas, Nov., 1890, A. S. Hitchcock, on *Hemidiodia ocimifolia* in Cuba, March, 1903, E. W. D. Holway, on *S. tenuior* in Jamaica, Feb., 1891, R. Thaxter, and on *S. aspera* in Jamaica, Jan., 1891, A. S. Hitchcock.

68. PUCCINIA ROSEA (Diet. & Holw.) Arth. Bot. Gaz. **40**: 206. 1905.

Aecidium roseum Diet. & Holw. Bot. Gaz. **24**: 36. 1897.

Uredo Agerati Mayor, Mem. Soc. Neuch. Sci. **5**: 595. 1913.

ON CARDUACEAE:

Ageratum conyzoides L., Villa Alba, Jan. 3, *112;* Utuado, Nov. 8, *4395;* Monte Alegrillo, Nov. 14, *4714, 4754.*

Eupatorium polyodon Urban, Barros, Jan. 2, *140.*

The several collections show urediniospores only, and in the

absence of teliospores the specific assignment must necessarily be somewhat doubtful.

The only other West Indian material referred to this species comes from Cuba, and also shows only uredinia. It is on *Eupatorium villosum* Sw., a common roadside weed in that region. The rust, which appears to be abundant, has been seen from three localities. It was collected at Gebara, March, 1903, by E. W. D. Holway, at Santiago de las Vegas, April, 1906, by W. T. Horne *17*, and occurs on a phanerogamic specimen in the N. Y. Bot. Garden from Cabanas Bay, collected March, 1912, by Britton & Cowell *12816*.

69. PUCCINIA TAGETICOLA Diet. & Holw. Bot. Gaz. **24**: 26. 1897.

ON CARDUACEAE:

Tagetes patula L., Maricao, Jan. 10, II, *200*.

This common Mexican rust has not before been reported from the West Indies. The host here represented is the French marigold of the gardens, introduced into cultivation over three hundred years ago from Mexico.

70. PUCCINIA SYNEDRELLAE P. Henn. Hedwigia 37: 277. 1898.

Puccinia solida Berk. & Curt. Jour. Linn. Soc. **10**: 356. 1869. Not *P. solida Schw.* 1832.

Puccinia Emiliae P. Henn. Hedwigia **37**: 278. 1898.

Dicaeoma cubense Kuntze, Rev. Gen. 3^3: 466. 1898.

Puccinia Tridacis Arth. Bull. Torrey Club **33**: 156. 1906.

Puccinia Eleutherantherae Diet. Ann. Myc. **7**: 354. 1909.

ON CARDUACEAE:

Eleutheranthera ruderalis (Sw.) Sch. Bip., Mayagüez, May 24, *1542;* Aguada, Nov. 22, *5095*.

Emilia sonchifolia DC., Hormigueros, Jan. 14, *212;* Guayama, Aug. 28, *2899;* Dec. 4, *5342;* Yauco, Oct. 3, *3141;* San German, Nov. 8, *5805*.

Synedrella nodiflora (L.) Gaertn., Barros, Jan. 2, *130;* Caguas, June 5, *2168;* Cabo Rojo, June 11, *2185;* St. Catalina, Aug. 28, *2733;* Yauco, Oct. 3, *3228;* Isabela, Oct. 22, *3736;* Rosario, Oct. 27, *3830*, without date,

4853; Alegrillo, Nov. 14, *4479;* Lares, Nov. 22, *4839;* San Sebastian, Nov. 22, *5200;* Guayama, Dec. 4, *5418;* Monte de Oro near Cayey, Dec. 3, *5675;* Jajome Alto, Dec. 3, *5682;* Utuado, Nov. 8, *5781;* Guayanilla, Nov. 13, *5922.*

Other Porto Rican collections of this species are as follows: On *Emilia sonchifolia,* Ponce, Jan., 1912, J. R. Johnston *202,* Rio Piedras, June, 1912, and Dec., 1913, J. R. Johnston *456, 1190,* Espinosa, Nov., 1914, J. A. Stevenson *2342;* on *Synedrella nodiflora,* Rio Piedras, June, 1912, J. R. Johnston, *448*, Trujillo Alto, Aug., 1913, J. R. Johnston *1041;* and on *Eleutheranthera ruderalis,* Buena Vista, Jan., 1915, J. A. Stevenson *2509.*

The species is common throughout the West Indies, as the following collections indicate: on *E. ruderalis,* eastern Cuba, 1856–7, Charles Wright (type of *Puccinia solida* B. & C.), Isle of Pines, Cuba, May, 1904, A. H. Curtis, and on phanerogamic specimens in the herbarium of the N. Y. Bot. Garden from Jamaica, June, 1897, A. Fredholm *3060,* from St. Domingo, June, 1910, Pater Fuertes, *174,* from Grenada, March, 1905, W. E. Broadway, and from Guadeloupe, 1893, Pére Duss *3264;* on *E. sonchifolia,* Jamaica, Jan., 1892, Lloyd *1082,* Oct.–Nov., 1902, F. S. Earle *32,* March, 1903, and Sept., 1906, L. M. Underwood *1737, 3168, 3352,* Feb., 1915, E. W. D. Holway *221,* Antigua, Feb. 13, Rose, Fitch & Russell *3315,* Martinique, Aug., 1913, F. L. Stevens *2973,* and on a phanerogamic specimen in N. Y. Bot. Garden from Grenada, 1904, W. E. Broadway; on *S. nodiflora,* Cuba, Aug., 1910, Britton, Earle & Gager *6272,* Jamaica, Dec., 1890, A. S. Hitchcock, April, 1903, L. M. Underwood, Feb., 1915, E. W. D. Holway *218,* Barbados, Oct., 1889, G. von Lagerheim (Sydow, Ured. *376*), and on a phanerogamic specimen from Tortola, April–May, 1913, W. C. Fishlock *22.*

The species has also been collected on *Tridax procumbens* L. in Cuba, Nov., 1904, Baker & O'Donovan *4039,* and on *Neurolaena lobata* (L.) R. Br. in Cuba, March, 1903, E. W. D. Holway.

The identification of the host for the type material of *Puccinia solida* B. & C. was made by Dr. B. L. Robinson of the Gray Herbarium in 1910, who found it to be *Eleutheranthera ruderalis.*

71. PUCCINIOSIRA PALLIDULA (Speg.) Lagerh. Tromsö Mus. Aarsh. **16**: 122. 1894.

Aecidiella Triumfettae Ellis & Kelsey, Bull. Torrey Club **24**: 208. 1897.

ON TILIACEAE:

Triumfetta rhomboidea Jacq., Santurce, Jan. 22, *256;* Mayagüez, Feb. 8, *282;* Aguada, Nov. 22, *5099.*

Triumfetta sp., Villa Alba, Jan. 3, *111;* Mayagüez, May 3, *1163, 1180,* June 13, *2217,* Oct. 31, *3928, 3943;* Bayamon, May 21, *1883;* Aibonito, June 5, *2134;* Maricao, Oct. 20, *3713;* Rosario, Oct. 27, *3769;* El Gigante near Adjuntas, Dec. 15, *6022;* River junction below Utuado, *6059.*

The other Porto Rican collections examined are on *T. Lappula* L., at Ponce, by A. A. Heller *6184,* 1902, on *T. rhomboidea* Jacq., at Santurce, by Cook & Collins *292,* at Mayagüez, by G. P. Clinton *173,* 1904, and on *Triumfetta* sp., at Rio Piedras, by Johnston & Seaver *991a,* 1913.

Material has also been examined from Guadeloupe, on *T. grandiflora,* Vahl., and from Jamaica on *T. semitriloba* L.

The species was gathered by Stevens at Caracas, Venezuela, July 15, 1913, on an undetermined species of *Triumfetta.*

The leaves of most species of *Triumfetta* are not distinguishable with certainty, and where inflorescence does not accompany the collection, specific determination of the host is usually impractical.

The transfer of the genus *Pucciniosira* from the family *Uredinaceae* to the *Aecidiaceae* is based upon a number of considerations, among which the aecidioid peridium and the intercalary cells of the catenulate teliospores have had much weight.

Form-genus: **Aecidium.**

Probably all forms listed here belong to heteroecious species under *Aecidiaceae.*

72. **Aecidium favaceum** sp. nov.

Pycnia amphigenous, very numerous on discolored spots, 3–5 mm. across, minute, evident, subcuticular, 60–90 μ across, flattened; ostiolar filaments wanting.

Aecia hypophyllous, crowded in groups on the pycnial area, hemispherical, soon open; peridium about 0.3 mm. across, delicate and evanescent; peridial cells oblong, 12–16 by 22–26 μ, readily separating, the walls 3–5 μ thick, the inner slightly thicker and strongly verrucose, the outer smooth, aeciospores globoid or broadly ellipsoid, 15–20 by 16–25 μ; wall nearly or quite colorless, 1.5–2 μ thick, minutely and closely verrucose.

ON EUPHORBIACEAE:

Phyllanthus nobilis (L. f.) Müll. Arg., San German, Jan. 16, *249*, May 25, *1849*, Dec. 12, *5832*; Hormigueros, Oct. 13, *3226* (type).

Three species of *Aecidium* have already been named which are said to be on *Phyllanthus* sp. Type material of *Aecid. detritum* Thüm. from Brazil has been examined and found quite unlike the West Indian species in all important details. The descriptions of *A. Phyllanthi* P. Henn. from New Guinea, and of *A. luzoniense* P. Henn. from the Philippines, also seem very unlike the material in hand, judging from descriptions.

73. AECIDIUM PASSIFLORIICOLA P. Henn. Hedwigia, 43: 168. 1904.

ON PASSIFLORACEAE:

Passiflora rubra L., Mayagüez, May 9, *1295*.

This form has been collected on the same host at Mayagüez, P. R., April, 1904, by G. P. Clinton *65*, and in Jamacia by L. M. Underwood, Jan. 1903, *82*, April, 1903, *1746*, and Sept., 1906, *3316*

74. AECIDIUM TOURNEFORTIAE P. Henn. Hedwigia 34: 338. 1895.

ON BORRAGINACEAE:

Tournefortia hirsutissima L., Yauco, Oct. 3, *3127*; Rosario, Oct. 27, *3781*.

The type collection was made in Brazil. It is here reported for North America for the first time.

75. AECIDIUM TUBULOSUM Pat. & Gaill. Bull. Soc. Myc. Fr. 4: 97. 1888.

Aecidium Uleanum Paz. Hedwigia **31**: 95. 1892.

Aecidium solaniphilum Speg. An. Mus. Nac. Hist. Nat. Buenos Aires **23**: 34. 1912.

ON SOLANACEAE:

Solanum torvum Sw., Mayagüez, May 10, 1912, *1, 2,* Jan. 30, *294bis* (Barth. Fungi Columb. *4202*); Corozal, Feb. 21, *403;* Yauco, Oct. 3, *3131;* Rosario, Oct. 27, *3776;* El Gigante near Adjuntas, Dec. 15, *4491;* Maricao, Nov. 18, *4807;* Lares, Nov. 22, *4844;* Adjuntas, Nov. 22, *4969;* Jajome Alto, Dec. 3, *5688;* Monte de Oro near Cayey, Dec. 3, *5733;* Jayuya, Dec. 17, *6045a;* Cabo Rojo, Dec. 27, *6483*.

A common and conspicuous rust, which is probably heteroecious. Other Porto Rican collections are on the same host; they are without locality, Geo. P. Goll *456,* 1899, Underwood & Griggs *26,* 1901, from near Santurce, A. A. Heller *1296,* 1899, from Mayagüez, G. P. Clinton *72,* 1904, from San Juan, E. W. D. Holway, 1911, and from Rio Piedras, H. B. Cowgill *503,* 1912. It has also been collected in Jamaica, Dec., 1890, by A. S. Hitchcock, and in Cuba, March, 1903, by E. W. D. Holway.

The type material of *A. solaniphilum* examined, kindly supplied by Dr. Spegazzini, resembles the other specimens in gross appearance of both fungus and host. The microscopic characters also agree, except that the peridial cells seem somewhat smaller and more delicate.

(*To be continued*)

THE GENUS CLITOCYBE IN NORTH AMERICA

William A. Murrill

(With Plates 164–166)

Before this large and difficult genus is published in *North American Flora,* it is thought advisable to present a preliminary paper which will direct attention to the group and add to our knowledge of it through additional collections and observations.

Species of *Laccaria,* formerly included in *Clitocybe,* have already been treated in *North American Flora,* volume 10, part 1. *Monadelphus* is another small segregate of *Clitocybe,* which is characterized by a densely cespitose, wood-loving hymenophore. The relation of these two genera to *Clitocybe* and to the segregates of *Tricholoma* may be indicated in the following key:

Lamellae decurrent or adnate.	
Spores not conspicuously verruculose or echinulate, usually ellipsoid; lamellae decurrent or adnate.	
Hymenophore usually solitary or gregarious; subcespitose to cespitose but not wood-loving in *C. multiceps* and a few other species.	Clitocybe.
Hymenophore densely cespitose and wood-loving, attached to decayed trunks or roots.	Monadelphus.
Spores conspicuously verruculose or echinulate, globose; lamellae adnate.	Laccaria.
Lamellae sinuate; spores usually ellipsoid and smooth.	
Pileus smooth or inconspicuously decorated with fibrils or scales.	Melanoleuca.
Pileus conspicuously decorated with fibrils or scales.	Cortinellus.

EASTERN SPECIES OF CLITOCYBE

Some of the species here included are confined to the eastern United States, while others may occur throughout temperate North America, or even in Europe or Asia. So little is at present known of the Rocky Mountain region, that it will be treated temporarily as a part of eastern North America. The New

York species have been studied very carefully by Dr. Charles H. Peck.

CLITOCYBE ADIRONDACKENSIS (Peck) Sacc. Syll. Fung. 5: 180. 1887

Agaricus adirondackensis Peck, Ann. Rep. N. Y. State Cab. **23**: 77. 1872.

Common in woods in the Adirondack region of New York, where it was discovered. Very near *C. infundibuliformis*, but distinguished by its narrow, crowded lamellae.

CLITOCYBE ALBIDULA Peck, Ann. Rep. N. Y. State Mus. **46**: 103 (23). 1893

Clitocybe centralis Peck, Ann. Rep. N. Y. State Mus. **53**: 841. 1900.

Described from specimens collected under pine trees at Delmar, New York. It is said to be related to *C. candicans*. Peck reduces *C. centralis* because it "differs from the type only in having the center of the moist pileus sometimes tinged with brown." The species occurs commonly in northern New York in pines or mixed woods and is abundantly represented at Albany.

Clitocybe albo-umbilicata (Hoffm.) comb. nov.

Agaricus umbilicatus Bolt. Hist. Fung. **1**: 36. 1795. Not *A. umbilicatus* Schaeff. 1774.

Agaricus candicans Pers. Syn. Fung. 456. 1801. Not *A. candicans* Schaeff. 1774.

Agaricus albo-umbilicatus Hoffm. Nom. Fung. —. 1789.

Described from Europe and reported from many parts of the eastern United States, occurring among fallen leaves in woods. Peck reports it common in New York, and I have found it plentiful in the Adirondacks.

CLITOCYBE APERTA (Peck) Sacc. Syll. Fung. **5**: 164. 1887

Agaricus (Clitocybe) apertus Peck, Ann. Rep. N. Y. State Mus. **30**: 38. 1878.

Described from Maryland, Otsego County, New York, and found rarely in groups or clusters in grassy ground by roadsides and in pastures. Peck first collected it in quantity and called it *C. dealbata,* a species which it resembles very closely.

CLITOCYBE BIFORMIS Peck, Bull. N. Y. State Mus. 150: 25. 1911

Known only from a single collection at North Elba in the Adirondacks, growing in circles or arcs of circles in mixed woods. Not distinct from *C. inversa.*

CLITOCYBE CAESPITOSA Peck, Ann. Rep. N. Y. State Mus. 41: 61. 1888

Described from the Catskill Mountains, New York, and found afterwards in the Adirondacks. It is a rare species, occurring in clusters in woods, and is remarkable for its irregular and deformed appearance. Specimens at Albany collected in Michigan by Beal resemble a young, subclustered stage of *C. adirondackensis,* and it seems probable that further studies may connect the two species.

CLITOCYBE CATINA (Fries) Quél. Champ. Jura Vosg. 215. 1872

Agaricus (*Clitocybe*) *catinus* Fries, Epicr. Myc. 72. 1838.

Reported once rather doubtfully from the Adirondack Mountains, New York, by Peck, who says that the species is related to *C. infundibuliformis,* but is easily distinguished by its white color. Reported also from Kansas by Bartholomew as occurring in short grass in the open prairie.

CLITOCYBE CHRYSOCEPHALA Sacc. Syll. Fung. 5: 190. 1887

Agaricus (*Clitocybe*) *auratocephalus* Ellis, Bull. Torrey Club 6: 75. 1876.

Described from Newfield, New Jersey, occurring there in swampy ground in July. The whole plant is golden-yellow and has a strong, peculiar smell. The spores are short-oblong and 10 μ long, very different from those of *Monodelphus illudens.* I have found no specimens of it in the Ellis collections, at least

among the white-spored agarics; it may possibly have been transferred to another series.

CLITOCYBE COLUMBANA (Mont.) Sacc. Syll. Fung. 5: 142. 1887

Agaricus (*Clitocybe*) *columbanus* Mont. Syll. Crypt. 102. 1856.

Described from specimens collected on naked ground at Columbus, Ohio. The types at Paris are large, closely clustered, and have the appearance of *Clitocybe illudens*, but the sphere are ellipsoid, $7 \times 4 \mu$. The color of the plant when fresh is not stated in the description.

CLITOCYBE CLAVIPES (Pers.) Quél. Champ. Jura Vosg. 48. 1872

Agaricus clavipes Pers. Syn. Fung. 353. 1801.

Agaricus carnosior Peck, Ann. Rep. N. Y. State Cab. 23: 76. 1872.

This well known edible species was described from Europe and occurs commonly on the ground in woods throughout most of temperate North America south to the mountains of North Carolina and west to Oregon.

CLITOCYBE COMPRESSIPES (Peck) Sacc. Syll. Fung. 5: 184. 1887

Agaricus (*Clitocybe*) *compressipes* Peck, Ann. Rep. N. Y. State Mus. 33: 18. 1883.

Described from Albany County, New York, growing in pastures or grassy places and later collected also in Warren County. Peck states that this species is near *C. ditopus,* but is distinguished by its umbilicate pileus and paler or whitish lamellae. Dodge reports it from Wisconsin, occasionally growing in clusters of twenty hymenophores. Compare *Hygrophorus.*

CLITOCYBE CONCAVA (Scop.) Gill. Champ. Fr. 150. 1874

Agaricus concavus Scop. Fl. Carn. ed. 2. 2: 449. 1772.

Agaricus cyathiformis Fries, Syst. Myc. 1: 173. 1821. Not *A. cyathiformis* Bull. *pl. 248.* 1785.

Agaricus Poculum Peck, Ann. Rep. N. Y. State Cab. 23: 77. 1872.

This shapely and easily recognized species was originally described from Paris by Vaillant, but the first binomial was assigned to specimens collected in Carniola. It is widely distributed on decaying wood or on the ground in woods or in mossy fields throughout Europe and the northern part of North America southward to South Carolina and Ohio and westward to Oregon and Bering Strait. The species has many names. That assigned by Fries and generally used is not tenable because it was antedated by Scopoli's name and also because the first plant to which Bulliard's name was assigned was not this species, but a smaller one usually known as *C. metachroa*. See *Clitocybe dicolor*.

CLITOCYBE CONNEXA (Peck) Sacc. Syll. Fung. **5**: 197. 1887

Agaricus (*Clitocybe*) *connexus* Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 45. 1873.

Described from specimens collected on the ground in woods at Croghan, New York. Dodge reports it from Wisconsin in low woods of maple and beech, and says that the pale, sky-blue colors mentioned by Peck are visible only at close range. In a recent bulletin, Peck makes this species a synonym of *C. Trogii* (Fries) Sacc. and says that it is closely allied to *C. virens*, from which it differs in the grayish and more compact pileus and the constantly solid stipe. It is said to have a fragrant, spicy odor.

CLITOCYBE DEALBATA (Sow.) Gill. Champ. Fr. 152. 1874

Agaricus dealbatus Sow. Engl. Fungi *pl. 123*. 1797.

This very common and well known species was described from England and occurs gregariously in open places throughout Europe and temperate North America. *C. sudorifica* Peck and *C. morbifera* Peck appear to be indistinguishable from this species morphologically, and it seems probable that we have to deal here with a species that varies in its physiological effects when ingested.

Clitocybe dicolor (Pers.) comb. nov.

Agaricus cyathiformis Bull. Herb. Fr. *pl. 248*. 1785. Not *A. cyathiformis* Schaeff. 1774.

Agaricus dicolor Pers. Syn. Fung. 462. 1801.
Agaricus metachrous Fries, Syst. Myc. 1: 172. 1821.
Clitocybe metachroa Quél. Champ. Jura Vosg. 216. 1872.

Described from Europe, where it is common in pine woods, and reported once by Peck in pine woods in Albany County, New York. It has also been reported from Maryland and New Brunswick. Hard's Ohio specimens are probably incorrectly determined. Romell has recently collected this species in abundance at Femsjö, Sweden, where it was first known to Fries. Bulliard's plate 248, containing the original description of *A. cyathiformis,* is said by Fries to represent two species, *C. metachroa* and *C. brumalis,* but I prefer to consider it as representing the two stages in *C. metachroa,* showing the change in color both of the surface and the lamellae. *C. brumalis* is very similar to *C. metachroa,* but the lamellae do not change color.

Clitocybe Earlei sp. nov.

Pileus thin, rather tough, convex to expanded, subumbonate, solitary or gregarious, reaching 8 cm. broad; surface glabrous, shining, subhygrophanous, smooth, dark-seal-brown when moist, fuscous when dry, margin entire, concolorous, inflexed; context firm, white with a brownish tint, the taste mild, slightly mawkish, the odor not characteristic; lamellae short-decurrent, several times inserted, some of them forking, densely crowded, narrow, white; spores ellipsoid, smooth, hyaline, $7.5–9 \times 5–6.5\,\mu$; stipe subcylindric, enlarged at the base, pallid when young, soon becoming concolorous, solid, smooth, glabrous, reaching 15 cm. long and 1–1.5 cm. thick.

Type collected on the ground in mixed, rocky woods at West Park, New York, August 6, 1903, *F. S. Earle 1753*. Not collected since.

CLITOCYE ECCENTRICA Peck, Bull. Torrey Club **25**: 321. 1898

Described from specimens collected on much decayed wood in Vermont and later collected in Connecticut, New York, Pennsylvania, western North Carolina, and Wisconsin. Dodge finds the stipe only slightly eccentric.

CLITOCYBE ECTYPOIDES (Peck) Sacc. Syll. Fung. **5**: 169. 1887

Agaricus (*Clitocybe*) *ectypoides* Peck, Ann. Rep. N. Y. State Mus. **24**: 61. 1872.

Described from Sandlake, New York, and occurring rather frequently on decaying wood in woods from Maine to Alabama and west to Wisconsin. I once made seven collections of it in Maine on dead coniferous wood.

CLITOCYBE ERUBESCENS (Mont.) Sacc. Syll. Fung. **5**: 150. 1887

Agaricus (*Clitocybe*) *erubescens* Mont. Syll. Crypt. 103. 1856. Not *A. erubescens* Fries, 1821.

Described from specimens collected on fallen logs at Columbus, Ohio, by Sullivant. The types at Paris, which are poorly preserved, suggest either a true *Clitocybe* or a species of *Hygrophorus*, near *H. pratensis*. The stipe is thick; the lamellae narrow to broad and distant; and the pileus smooth, viscid, and 2.5 cm. broad in its present dried state. The spores are oblong-ellipsoid, somewhat fusiform, smooth, hyaline, $4\text{–}5 \times 2\text{–}3\,\mu$.

CLITOCYBE FELLEA Peck, Ann. Rep. N. Y. State Mus. **51**: 284. 1898

Found once at Gansevoort, Saratoga County, New York, growing gregariously on the ground in woods. The author cites the pale color, deep umbilicus, and bitter taste as prominent characters. I have not seen this species.

CLITOCYBE FLACCIDA (Sow.) Quél. Champ. Jura Vosg. 329. 1873

Agaricus flaccidus Sow. Engl. Fungi *pl. 185*. 1798. Not *Agaricus flaccidus* Bull. 1788.

Described from England and reported as occurring in pine woods in Massachusetts and Maryland. A study of Sowerby's plate and of specimens at Kew, in connection with specimens collected at Paris, leads me to believe that this is none other than our old friend *C. inversa;* in which case its occurrence in this country is correctly reported.

CLITOCYBE FLAVIDELLA (Peck) Sacc. Syll. Fung. 5:197. 1887

Agaricus (Clitocybe) flavidellus Peck, Ann. Rep. N. Y. State Mus. 30:38. 1878.

Found only once growing gregariously in wet, swampy ground at Maryland, Otsego County, New York. The type specimens may still be seen at Albany.

CLITOCYBE FUMOSA (Pers.) Quél. Champ. Jura Vosg. 214. 1872

Agaricus fumosus Pers. Syn. Fung. 348. 1801.

Described from Europe as frequent in woods and grassy places, and reported from New England, New York, Pennsylvania, and North Carolina. Bambeke says it sometimes grows in circles. Peck reports it from Albany and Ontario Counties. The specimens at Albany formerly labeled *C. ampla* Pers. are now marked *C. fumosa.*

CLITOCYBE FUSCIPES Peck, Ann. Rep. N. Y. State Mus. 44:129 (17). 1891

Found only once under pine trees at Carrollton, Cattaraugus County, New York. The small type specimens are still preserved at Albany.

CLITOCYBE GALLINACEA (Scop.) Gill. Champ. Fr. 150. 1874

Agaricus gallinaceus Scop. Fl. Carn. ed. 2. 2:433. 1772.

Described from Carniola and reported once by Peck from the Adirondacks, New York, occurring in grassy or mossy places. Peck states that it has a decidedly acrid taste and strong odor and that its color is dingy-white.

CLITOCYBE GERARDIANA (Peck) Sacc. Syll. Fung. 5:181. 1887

Agaricus (Clitocybe) Gerardianus Peck, Bull. Buffalo Soc. Nat. Sci. 1:46. 1873.

Described from Sandlake, New York, occurring in sphagnous marshes, and later collected at New Platz, New York. This was transferred to *Omphalia* in 1893, where it seems to belong. Peck says it is related to *C. ectypoides,* but is much more slender and fragile.

CLITOCYBE GIGANTEA (Sow.) Quél. Champ. Jura Vosg. 51. 1872

Agaricus giganteus Sow. Engl. Fungi *pl. 244.* 1800.

Reported from Wisconsin by Dodge, who says it differs from *Clitocybe maxima* in having a much shorter and thicker stipe.

Clitocybe hiemalis nom. nov.

Agaricus brumalis Fries, Obs. Myc. 2:206. 1818. Not *A. brumalis* Scop. 1772.

Described from Europe and reported by Peck as rare in woods in the Catskills and Adirondacks; also previously reported from North Carolina and Greenland. I found it in abundance in Kew Gardens in November, 1910.

CLITOCYBE HOFFMANI (Peck) Sacc. Syll. Fung. 5:197. 1887

Agaricus (*Clitocybe*) *Hoffmani* Peck, Ann. Rep. N. Y. State Mus. 24:60. 1872.

Known only from specimens collected on much decayed wood in woods at Greig, New York. As this species is not mentioned in Peck's recent state list, it may have been transferred by him to some other genus.

CLITOCYBE INFUNDIBULIFORMIS (Schaeff.) Quél. Champ. Jura Vosg. 52. 1872

Agaricus infundibuliformis Schaeff. Fung. Bavar. 4: Ind. 49. 1774.

This extremely common species was originally described from Europe and occurs among fallen leaves in woods throughout eastern temperate North America westward as far as Iowa and Kansas. The plant tends to assume somewhat darker colors in Europe, so far as I have observed.

CLITOCYBE INVERSA (Scop.) Quél. Champ. Jura Vosg. 214. 1872

Agaricus inversus Scop. Fl. Carn. ed. 2. 2:445. 1772.

Agaricus gilvus Pers. Syn. Fung. 448. 1801.

Clitocybe maculosa Peck, Bull. Buffalo Soc. Nat. Sci. 1:45. 1873.

Agaricus (*Clitocybe*) *subzonalis* Peck, Bull. Buffalo Soc. Nat. Sci. 1:46. 1873.

Clitocybe biformis Peck, Bull. N. Y. State Mus. 150:25. 1911.

This large and handsome species was described from Carniola and occurs in humus in woods or groves throughout Europe and the northern United States, having been collected rather commonly in Maine, New York, Washington, and Oregon. In Paris, the writer once found it growing in the greatest profusion beneath the giant cedar of Lebanon at the south end of the Jardin des Plantes. The species must have been very familiar to Bulliard, who figured it in his plate 553 under the name of *Agaricus infundibuliformis,* one of its many appellations. *C. geotropa* is said to have spores 6–7 × 4–5 μ, while those of *C. inversa* are 4.5–5 × 3–4 μ.

CLITOCYBE LEPTOLOMA Peck, Bull. N. Y. State Mus. 157:68. 1912

Agaricus (*Clitocybe*) *leptolomus* Peck, Ann. Rep. N. Y. State Mus. 32:26. 1880.

Described from specimens on decaying prostrate trunks in woods at Indian Lake in the Adirondack Mountains, New York. It is reported as uncommon and no other locality is cited for the species. It is said to differ from *C. truncicola* in having a hygrophanous, umbilicate pileus.

CLITOCYBE MACULOSA (Peck) Sacc. Syll. Fung. 5:183. 1887

Agaricus (*Clitocybe*) *maculosus* Peck, Bull. Buffalo Soc. Nat. Sci. 1:45. 1873. Not *A. maculosus* Pers. 1801.

Described from specimens collected on the ground in woods at Croghan, New York. Not distinct from *C. inversa.*

CLITOCYBE MAXIMA (Gärtn. & Meyer) Quél. Champ. Jura Vosg. 51. 1872

Agaricus maximus Gärtn. & Meyer, Fl. Wett. 3^2:329. 1802.

I examined this species in the Hooker herbarium at Kew and elsewhere, but found no specimens from America and its occurrence here must be considered doubtful, although it has been reported from Minnesota, Massachusetts, California, and else-

where. Peck says it is rare in the Adirondacks and Catskills, occurring in woods and grassy places, and that it is easily recognized by its large size. Dodge reports it from Wisconsin.

CLITOCYBE MEDIA Peck, Ann. Rep. N. Y. State Mus. **42**: 114 (18). 1889

Described from North Elba in the Adirondack Mountains, New York, occurring there rarely on mossy ground in woods, and later reported from Wisconsin. Peck considers it intermediate between *C. nebularis* and *C. clavipes,* but it certainly approaches the latter species very closely.

CLITOCYBE MEGALOSPORA Clements, Bot. Surv. Neb. **4**: 18. 1896

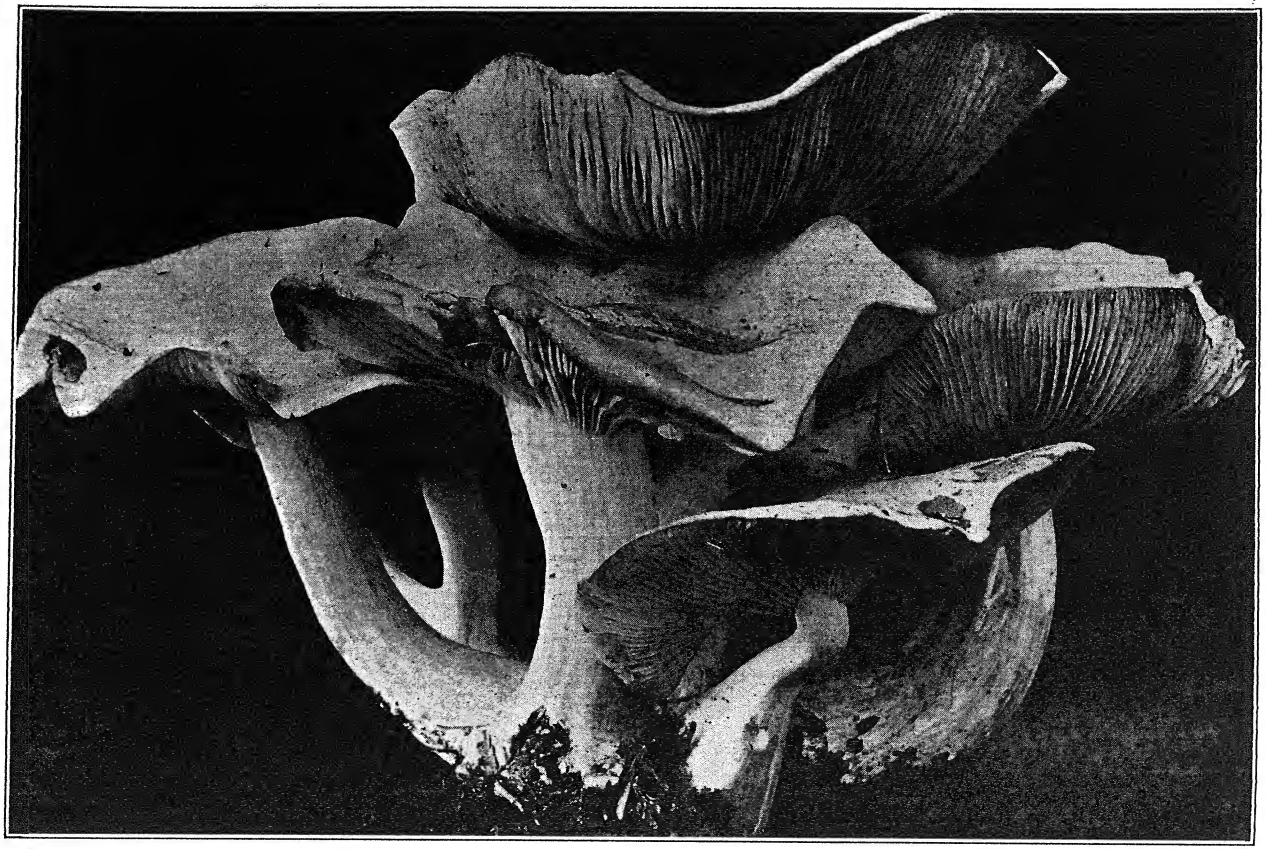
Not a species of *Clitocybe.* See *Mycologia* **7**: 157. 1915.

CLITOCYBE MORBIFERA Peck, Bull. Torrey Club **25**: 231. 1898

Described from specimens collected on grassy ground and lawns at Washington, D. C., by F. J. Braendle. The taste is reported as very disagreeable and persisting for a long time. Two by Dr. Fischer from Detroit, Michigan, and in both cases sickness lasting about three hours. In Bulletin 150, Peck reports specimens sent by Dr. Whetstone from Minneapolis, Minnesota, and by Dr. Fischer from Detroit, Michigan, and in both cases sickness was produced after the fungus had been eaten in quantity. Dr. Peck concludes that although *C. morbifera* is scarcely distinguishable morphologically from *C. sudorifica* the ill effects of the former are much more serious and uncomfortable than those of the latter species. Specimens of *C. dealbata* collected at Seattle were compared at Albany with specimens of *C. morbifera* collected by Dr. Whetstone in Minnesota in 1905, and found to agree in every particular.

CLITOCYBE MULTICEPS Peck, Ann. Rep. N. Y. State Mus. **43**: 17. 1890

This large and important edible species was originally described from Albany and Sandlake, New York, occurring in open grassy places in late spring or early summer and again in the



CLITOCYBE MULTIFORMIS PECK

autumn. It has been described and twice figured in *Mycologia.* Sometimes the lamellae are adnexed or slightly sinuate, suggesting *Melanoleuca.* The species is known to occur in many parts of the eastern United States from Canada to New Jersey, and it may possibly extend westward to Washington. It is very abundant in some localities in the vicinity of New York City. By removing pieces of sod containing the mycelium, it is possible to transplant it rather easily, and it increases rapidly when once established in a lawn.

CLITOCYBE MULTIFORMIS Peck, Mem. N. Y. State Mus. 3:141. 1900

Described from several specimens collected at one time in Albany County, New York, growing in a low damp place in woods. Although a prominent species and well illustrated by Peck, it has not been reported since. It is said to be smaller and thinner than *Clitocybe multiceps,* although similar in habit and edible. The pileus is whitish, grayish, or yellowish when moist becoming paler when dry. What appears to be this species was twice collected at Stockbridge, Massachusetts, by Dr. W. Gilman Thompson and myself early in October, 1911. (*pl. 164*).

CLITOCYBE NOBILIS Peck, Bull. Torrey Club 34:97. 1907

Described and known only from specimens collected on humus and buried wood at Deer Lake, Ontario, by C. Gillet. The type specimens at Albany appear quite distinct, with particularly long stipes.

CLITOCYBE PELTIGERINA (Peck) Sacc. Syll. Fung. 5:184. 1887

Agaricus (*Clitocybe*) *peltigerinus* Peck, Ann. Rep. N. Y. State Mus. 30:38. 1885.

This rare species was described from specimens collected on decaying *Peltigera* at Oneida, New York, and afterwards found at North Greenbush, New York. The minute type specimens may be seen at Albany.

CLITOCYBE PHYLLOPHILA (Pers.) Quél. Champ. Jura Vosg. 49. 1872

Agaricus phyllophilus Pers. Syn. Fung. 457. 1801.

This species was described from Europe and is reported by Peck as rare in Albany County; and also by other mycologists from Massachusetts, North Carolina, Ohio, Indiana, Minnesota, and Wisconsin. I have a number of recent collections of the plant from Vermont, Massachusetts, and New York. It occurs among sticks and leaves on the ground in woods.

CLITOCYBE PHYLLOPHILOIDES Peck, Bull. N. Y. State Mus. 167: 19. 1915

Described from specimens collected among fallen leaves in spruce woods at Constableville, New York. The types have not been examined.

Clitocybe pileolaria (Bull.) comb. nov.

Agaricus pileolarius Bull. Herb. Fr. *pl. 400.* 1788.
Agaricus nebularis Batsch, Elench. Fung. Contin. 2: 25. 1789.
Agaricus mollis Bolt. Hist. Fung. 1: 63. 1795.
Clitocybe nebularis Quél. Champ. Jura Vosg. 48. 1872.

Originally described from France, occurring among dead leaves in woods, and very well figured by Bulliard, as well as by Barla, Bresadola, Fries, Hussey, Bolton, and others. Peck's figures in Report 48 are not suggestive of the European plant, and the spores of his specimens are $4–6 \times 2–3\,\mu$, while those of the European plant are $8–10 \times 5–7\,\mu$. The species has been reported from Canada to North Carolina and west to the Rocky Mountains, and there are many specimens so named at Albany, but apparently there remains much to be determined regarding its occurrence in this country.

CLITOCYBE PINIARIA (Bosc) Sacc. Syll. Fung. 5: 148. 1887

Agaricus piniarius Bosc, Ges. Nat. Freunde Berlin Mag. 5: 84. 1811.
Agaricus (Clitocybe) piniarius Fries, Epicr. Myc. 59. 1838.

Described and known only from specimens collected in pine woods in South Carolina. Fries did not see these specimens.

CLITOCYBE PINOPHILA (Peck) Sacc. Syll. Fung. 5: 183. 1887

Agaricus (*Clitocybe*) *pinophilus* Peck, Ann. Rep. N. Y. State Mus. 31: 32. 1879.

Described from Albany, New York, occurring rarely under or near pine trees, and reported later from Essex and Warren Counties, New York.

CLITOCYBE PITHYOPHILA (Fries) Gill. Champ. Fr. 152. 1874

Agaricus (*Clitocybe*) *pithyophilus* Fries, Syst. Myc. 1: 83. 1821.

Described from Europe and reported from New England, New York, and Ohio, usually occurring in pine woods. Hard gives a good illustration of this species in his recent work.

CLITOCYBE PORPHYRELLA (Berk. & Curt.) Sacc. Syll. Fung. 5: 196. 1887

Agaricus (*Clitocybe*) *porphyrellus* Ann. Mag. Nat. Hist. III. 4: 284. 1859.

Described from specimens collected in leaf-mold in Connecticut by Wright. The types at Kew are old and unreliable for comparison. The pale-purple color of the entire plant would seem to suggest *Mycena pura* or one of the species of *Laccaria*.

CLITOCYBE PRUINOSA Lovejoy, Bot. Gaz. 50: 384. 1910.
Not *Clitocybe pruinosa* (Lasch) Quél. 1872

Described from specimens collected in open pine woods at Foxpark, Wyoming, August 14, 1909. The pileus is described as 3.5 cm. wide, smooth, and rich-reddish-brown over salmon; the lamellae as salmon-yellow, crowded, and very decurrent; and the spores as globose, spiny, 7–10.5 μ. This would seem to indicate a species of *Laccaria* if the lamellae were not so decurrent. Its relationship may be with *C. sinopica*.

CLITOCYBE PULCHERRIMA Peck, Jour. Myc. **14**: 1. 1908

Described from specimens collected by Dr. O. E. Fischer among fallen leaves near Detroit, Michigan. The types of this beautiful, lemon-yellow species are at Albany.

CLITOCYBE RADIOZONARIA (Johnson) Sacc. Syll. Fung. **9**: 20. 1891

Agaricus (*Clitocybe*) *radiozonarius* Johnson, Bull. Minn. Acad. Sci. **1**: 214. 1887.

Described from Minnesota, occurring on decaying fallen branches and stumps in June. The specimens are lost, but the description resembles that of *Crinipellis zonata.*

Clitocybe rancidula (Banning & Peck) comb. nov.

Tricholoma rancidulum Banning & Peck; Peck, Ann. Rep. N. Y. State Mus. **44**: 179 (67). 1891.

Known only from specimens collected in vegetable mold in Druid Hill Park, Baltimore, Maryland, by Miss Banning. The lamellae are slightly decurrent and very narrow and crowded. The plant is larger than *T. personatum,* the stipe is not bulbous, and the margin of the pileus is finely striate for about 2 cm. Its odor is very rancid, whence the name.

CLITOCYBE REGULARIS Peck, Bull. N. Y. State Mus. **10**: 948. 1902

Described from specimens collected among fallen leaves in woods at Bolton, New York. Specimens recently collected at Austin, Texas, by F. McAllister appear to correspond to the New York specimens in every particular.

CLITOCYBE RIVULOSA (Pers.) Quél. Champ. Jura Vosg. 214. 1872

Agaricus rivulosus Pers. Syn. Fung. 369. 1801.

Described from Europe and twice reported by Peck from the Adirondacks. It was also reported from the Antilles by Fries in 1851.

CLITOCYBE ROBUSTA Peck, Ann. Rep. N. Y. State Mus. 49: 17. 1897

Described from the Catskill Mountains and found several times since in New York, growing among fallen leaves in woods. It has been reported from as far south as Maryland and as far west as Wisconsin. *Clitocybe candida* Bres. has been confused with this species.

CLITOCYBE SETISEDA (Schw.) Sacc. Syll. Fung. 5: 176. 1887

Agaricus (*Omphalia*) *setisedus* Schw. Schr. Nat. Ges. Leipzig 1: 88. 1822.

Agaricus (*Clitocybe*) *setisedus* Fries, Epicr. Myc. 73. 1836.

Described from North Carolina, occurring among fallen leaves. I have seen no specimens.

CLITOCYBE SINOPICA (Fries) P. Karst. Bidr. Finl. Nat. Falk 32: 73. 1879

Agaricus sinopicus Fries, Obs. Myc. 2: 197. 1818.

Described from Europe and frequent in woods and on burned ground in open places throughout most of temperate North America, having been found as far south as Tennessee and South Carolina and west to the Pacific coast. *Clitocybe Arnoldi* Boud. is only a variety of this species. *Agaricus* (*Tricholoma*) *Sienna* Peck also appears to be a large form of the same plant. *Clitocybe subconcava* Peck is very near.

CLITOCYBE SINOPICOIDES Peck, Bull. N. Y. State Mus. 157: 80. 1912

Described from the Adirondacks, occurring there among mosses in low, wet places. Peck says it differs from *C. sinopica* in its habitat, smaller size, and smaller spores, but all these differences appear to me to be very slight. I have some small specimens collected in Maine which Bresadola pronounced "not *sinopica*," but which correspond to specimens at Albany determined as *C. sinopica*. Bresadola's idea of *C. sinopica* is a rather large plant with a much thicker stipe than is usually seen in our American specimens.

CLITOCYBE SOCIALIS (Fries) Sacc. Syll. Fung. **5**: 149. 1887

Agaricus socialis Fries, Hymen. Eur. 83. 1874.

Reported by Moffatt as occurring among dead leaves on a wooded hillside in the vicinity of Chicago, Illinois. He says that it is remarkable for its very acute umbo, and that the spores are globose, echinulate, 9–10 μ. I have not seen his specimens.

CLITOCYBE SPLENDENS (Pers.) Gill. Champ. Fr. 139. 1874

Agaricus splendens Pers. Syn. Fung. 452. 1801.

Described from Europe and reported by Peck as rare among fallen leaves in woods in the Adirondacks. It is very probable that American specimens bearing this name may all be referred to *C. sinopica*, *C. subsquamata*, or *C. inversa*.

CLITOCYBE SUBCONCAVA Peck, Bull. N. Y. State Mus. **54**: 948. 1902

Described from Bolton, New York, growing in pine woods. There are seven specimens on the type sheet at Albany, but the species has not been reported since. It should be carefully compared with forms of *C. sinopica*.

Clitocybe subconnexa sp. nov.

Pileus convex to expanded, rather thin, very tender and fragile, somewhat cespitose, reaching 9 cm. broad; surface smooth, dry, glabrous, milk-white; margin very thin, concolorous, entire, strongly incurved on drying; context thin, white, fragile, with pleasant odor and taste; lamellae short-decurrent or adnate, narrow, white, exceedingly crowded, several times inserted; spores ellipsoid, smooth, hyaline, $5 \times 3.5\ \mu$; stipe fleshy, subequal, smooth, glabrous, white, hollow, 5–7 cm. long, reaching 1.5 cm. thick.

Type collected in rich soil under trees in the New York Botanical Garden, September 26, 1911, *W. A. Murrill*. Also collected in the grass near the herbaceous nursery of the New York Botanical Garden, September 25, 1907, *R. C. Benedict*. This species somewhat resembles *C. multiceps* but it is thinner and more fragile and the lamellae are much more crowded.

CLITOCYBE SUBCYATHIFORMIS Peck, Bull. N. Y. State Mus. **122**: 136. 1908

Described from specimens collected among fallen leaves under alders and birches in Albany and Warren Counties, New York. It is said to be rare. The species is well illustrated, and the types, which somewhat resemble *C. infundibuliformis,* are at Albany.

CLITOCYBE SUBDITOPODA Peck, Ann. Rep. N. Y. State Mus. **42**: 114 (18). 1889

Originally collected in mossy ground in woods in the Adirondack Mountains at North Elba, New York, and reported by Peck as rare. I collected the species near Lake Placid in July and in October, 1912. Peck says it differs from *C. ditopoda* Fries in its umbilicate pileus, striate margin, and broader, paler lamellae.

CLITOCYBE SUBHIRTA Peck, Bull. N. Y. State Mus. **1**[2]: 11. 1888

Agaricus (*Clitocybe*) *subhirtus* Peck, Ann. Rep. N. Y. State Mus. **32**: 25. 1880.

Described from specimens collected at Brewerton, New York, occurring there on the ground in woods. There are four good specimens on the type sheet at Albany. The lamellae are broad and have a peculiar rosy-cream color as in some species of *Russula*. Specimens collected at Stockbridge, Massachusetts, in October, 1911, seem to correspond exactly with the types. In my field notes, I remark that the lamellae are sinuate and that the plant is probably a *Melanoleuca.*

Clitocybe submarmorea nom. nov.

Agaricus (*Clitocybe*) *marmoreus* Peck, Ann. Rep. N. Y. State Mus. **24**: 61. 1872. Not *A. marmoreus* Lam.

This large, cespitose species was described from specimens found on prostrate trunks of trees in woods at Greig, New York, and has not been reported since. The clusters are composed of few individuals. There are two specimens at Albany, accom-

panied by an excellent sketch. The surface is represented as white mottled with darker, watery spots.

CLITOCYBE SUBNIGRICANS Peck, Bull. N. Y. State Mus. 150: 51. 1911

Described from specimens collected by G. B. Fessenden, at Rye Beach, New Hampshire. The types at Albany have not been examined. Reported by the author as a fine species, easily distinguishable by its strong odor and the blackening of the lamellae and stipe when bruised or on drying.

CLITOCYBE SUBSIMILIS Peck, Ann. Rep. N. Y. State Mus. 41: 61. 1888

Described from specimens collected under pine trees in the Catskill Mountains, New York. After examining the excellent type specimens at Albany, I have referred the species to *Melanoleuca albissima* (Peck) Murrill.

Clitocybe subsquamata nom. nov.

Agaricus squamulosus Pers. Syn. Fung. 449. 1801. Not *A. squamulosus* Bull. 1785.

Described from Europe, where it is rare, and occurring frequently in the Adirondacks, usually under pines. The spores measure $5–7 \times 3–5\,\mu$. Care must be taken not to confuse this species with *C. sinopica*.

CLITOCYBE SUBZONALIS (Peck) Sacc. Syll. Fung. 5: 184. 1887

Agaricus (*Clitocybe*) *subzonalis* Peck, Bull. Buffalo Soc. Nat. Sci. 1: 46. 1873.

Described from specimens collected on the ground in woods at Croghan, New York. Not distinct from *C. inversa*.

CLITOCYBE SUDORIFICA Peck, Bull. N. Y. State Mus. 157: 67. 1912

Clitocybe dealbata sudorifica Peck, Bull. N. Y. State Mus. 150: 43. 1911.

First described as a variety of *C. dealbata* from specimens collected in grassy ground at Saratoga, New York, by F. G. Howland. It has been collected in two or three other localities in Albany and Ontario Counties. Mr. Howland, Dr. Peck, and Dr. W. W. Ford all agreed that this mushroom was decidedly sudorific and unwholesome, differing decidedly in this respect from the reputation enjoyed by *C. dealbata*. I have examined the types, however, and can see no morphologic difference between the two plants. They both grow gregariously in exposed grassy places and the best observer could not tell them apart. See notes on *C. morbifera* Peck.

CLITOCYBE SULPHUREA Peck, Ann. Rep. N. Y. State Mus. **41**: 62. 1888

Described and known only from specimens collected on decaying wood of spruce and balsam fir on Wittenberg Mountain in the Catskills, New York. There are five rather young specimens on the type sheet at Albany. They appear to be related to *Cortinellus decorus,* but the surface is not squamulose.

CLITOCYBE TRULLISATA (Ellis) Sacc. Syll. Fung. **5**: 195. 1887

Agaricus (*Clitocybe*) *trullisatus* Ellis, Bull. Torrey Club **5**: 45. 1874.

Described from specimens collected in an old sandy field at Newfield, New Jersey, and later reported in sandy soil in Suffolk, Nassau, Madison, and Albany Counties, New York. Peck remarks that the species resembles larger forms of *Laccaria laccata,* but it has a stouter habit, the pileus is more squamulose, the stipe is bulbous, the mycelium violet-colored, and the spores oblong. The spores are described as oblong or cylindric, smooth, granular within, $15–20 \times 8–9\,\mu$.

Clitocybe tenebricosa sp. nov.

Pileus convex, becoming depressed at the center with the margin upturned, gregarious, reaching 6 cm. broad; surface smooth, white, glabrous; context white, rather thin, without characteristic odor; lamellae crowded, somewhat ventricose,

short-decurrent, inserted, white; spores globose, smooth, hyaline, 4–6 μ; stipe subfusiform, hollow, smooth, white, glabrous, reaching 12 cm. long and 2 cm. thick. (*pl. 165*).

Type collected September 25, 1908, by *George H. Plass* on the side of a trench under the museum building of the New York Botanical Garden, growing out between brickwork in total darkness, evidently arising from soil, as no wood was present. This species suggests one found by Miss Banning growing in cluster on a brick wall in a cellar at Baltimore, Maryland, and named by her *Agaricus* (*Tricholoma*) *cellaris,* but I believe the description was never published. The spores of Miss Banning's plant seem quite different from those of the species described above.

CLITOCYBE TRUNCICOLA (Peck) Sacc. Syll. Fung. **5**: 184. 1887

Agaricus (*Clitocybe*) *truncicola* Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 46. 1873.

Described from Croghan, New York, and said to be rare except in the Adirondack Mountains, occurring on the trunks of deciduous trees, especially those of the sugar maple.

CLITOCYBE VILESCENS (Peck) Sacc. Syll. Fung. **5**: 184. 1887

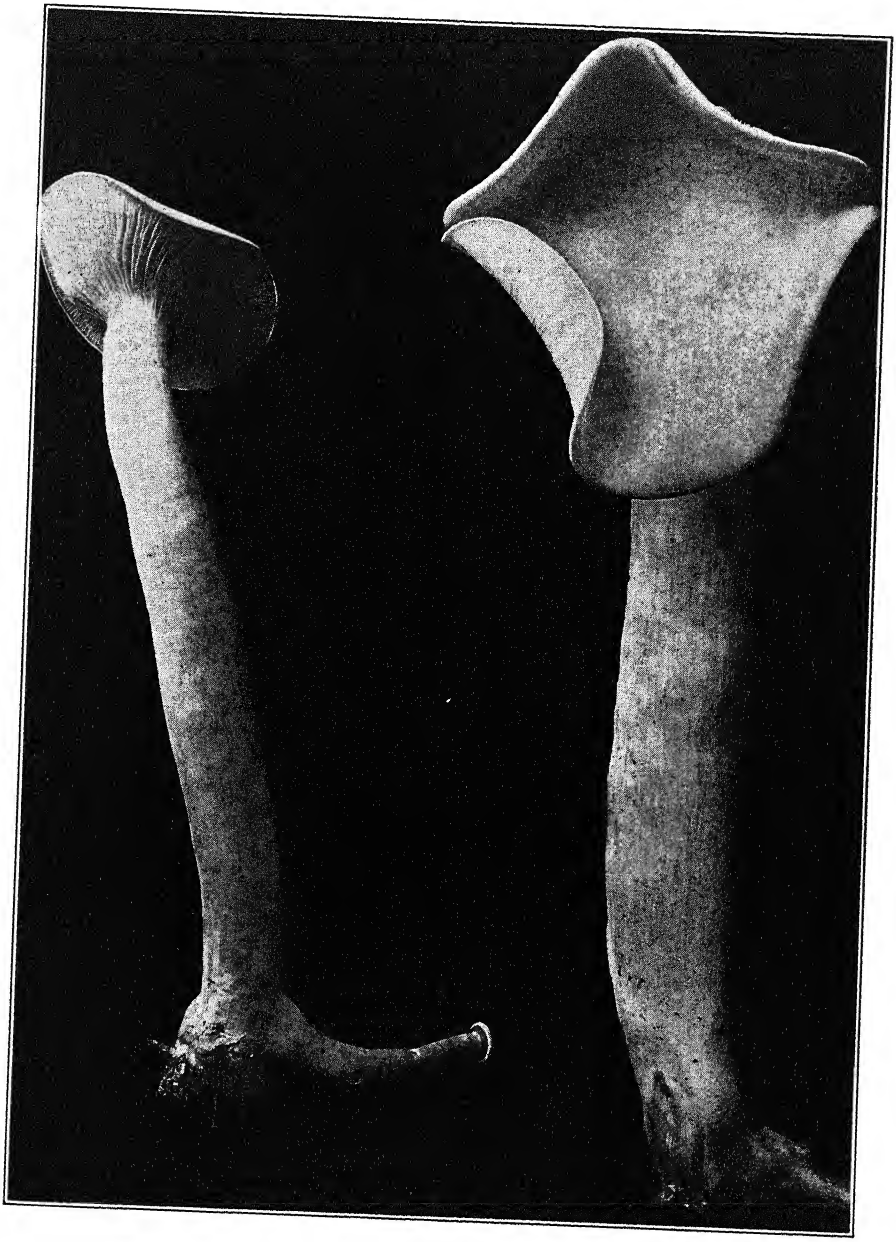
Agaricus (*Clitocybe*) *vilescens* Peck, Ann. Rep. N. Y. State Mus. **33**: 19. 1883.

Described from specimens collected in grassy pastures at Jamesville, New York, and reported later as occurring rarely in bushy places and pastures in Albany and Onondaga Counties. In describing a pale form occurring in the sand, Peck states that the flavor is mild and agreeable.

CLITOCYBE VIRENS (Scop.) Sacc. Syll. Fung. **5**: 152. 1887

Agaricus virens Scop. Fl. Carn. ed. 2. **2**: 437. 1772.
Agaricus odorus Bull. Herb. Fr. *pl. 176*. 1783.
Agaricus viridis Huds. Fl. Angl. ed. 2. **1**: 614. 1778.
Agaricus (*Clitocybe*) *anisarius* Peck, Ann. Rep. N. Y. State Mus. **32**: 26. 1879.

Described from Carniola and found commonly in open woods and bushy places throughout Europe and in the eastern United



CLITOCYBE TENEBRICOSA MURRILL

CLITOCYBE VIRENS (SCOP.) SACC.

States from Maine to North Carolina and west to Michigan. *C. odora* and *C. virens* are still kept distinct at Paris, probably following the opinion of Fries, but in England and America the two are considered synonyms. The specimens, descriptions, and illustrations everywhere agree, so far as I have examined them. The plant appears each season in the New York Botanical Garden among dead leaves in the edges of deciduous woods. Owing to its brilliant coloring and agreeable odor, it is decidedly attractive when young and fresh, but it is apt to fade with age and become confused with other species. (*pl. 166*).

COLLYBIA AQUOSA ADNATIFOLIA Bull. N. Y. State Mus. **2**: 25. 1887

Peck states in his 49th report that this variety is probably a *Clitocybe*.

TRICHOLOMA CELLARE Banning & Peck; Peck, Ann. Rep. N. Y. State Mus. **44**: 179 (67). 1891

This name was published by Peck without description or comment, although Miss Banning's manuscript drawing and notes are quite complete. The lamellae being decurrent, the plant is a *Clitocybe;* or, if it grows on wood, a *Monadelphus*.

TRICHOLOMA SIENNA (Peck) Sacc. Syll. Fung. **5**: 137. 1887

Agaricus (*Tricholoma*) *Sienna* Peck, Ann. Rep. N. Y. State Mus. **24**: 60. 1872.

Described from specimens collected on the ground in woods at Greig, New York, and apparently not reported since. A good drawing accompanies the types at Albany, and there is little doubt that this species is only a rather large form of *Clitocybe sinopica*.

WESTERN SPECIES OF CLITOCYBE

The genus *Clitocybe* is abundantly represented on the Pacific coast, where the author in 1911 discovered many novelties. The following 21 new species from Washington, Oregon, and Cali-

fornia were published in *Mycologia* for July, 1913: *Clitocybe albicastanea, C. albiformis, C. atrialba, C. avellaneialba, C. brunnescens, C. cuticolor, C. griseifolia, C. Harperi, C. hondensis, C. murinifolia, C. oculata, C. oreades, C. oregonensis, C. Peckii, C. stipitata, C. subcandicans, C. subinversa, C. subfumosipes, C. variabilis, C. violaceifolia,* and *C. washingtonensis.*

A number of additional interesting specimens have only recently been sent in from the Pacific coast, which indicates that the field is by no means exhausted.

CLITOCYBE CLAVIPES (Pers.) Quél. Champ. Jura Vosg. 48. 1872

An excellent specimen of this species was sent me in November, 1913, by Dr. H. D. House from Marshfield, Oregon. It was collected in fir woods in that locality by Mr. W. Haydon and marked number 21.

CLITOCYBE DICOLOR (Pers.) Murrill, Mycologia 7: 260. 1915

This species was collected by Macoun on St. Paul Island, Bering Sea.

CLITOCYBE DEALBATA (Sow.) Gill. Champ. Fr. 152. 1874

This species is common in grassy places and seems to be about the same as in the eastern United States, only a little larger and with the lamellae usually somewhat more distant. It was sometimes found growing in rings.

Seattle, Washington, *Murrill 402, 513;* Tacoma Prairies, Washington, *Murrill 710;* Corvallis, Oregon, *Murrill 953, 1003;* Newport, Oregon, *Murrill 1045;* Berkeley, California, *Yates 84, 60;* Golden Gate Park, California, *Murrill 1115;* Marin County, California, *Alice Eastwood 35;* Presidio, California, *Harper 65;* Stanford University, California, *Dudley 188, 322, McMurphy 159.*

CLITOCYBE INVERSA (Scop.) Quél. Champ. Jura Vosg. 214. 1872

This species is very abundant in Washington and Oregon, occurring especially in coniferous woods. In one locality near Seattle, I found seventy plants growing in a perfect ring six feet

in diameter. The hymenophore is very variable in color, ranging from pale-yellow to orange; the taste is astringent and unpleasant at first, soon becoming nutty and less unpleasant, though the astringent effects remain.

Seattle, Washington, *Murrill 382, 390, 406, 408, 458, 613, 668, Zeller 24;* Newport, Oregon, *Murrill 1072, 1091;* Salem, Oregon, *M. E. Peck;* Seaside, Oregon, *House 12.92;* Portola, California, *McMurphy 50.*

CLITOCYBE MICROSPORA Peck, Bull. Torrey Club **36**: 331. 1909

Described from specimens collected by C. F. Baker at Claremont, California, in January. Peck says it is related to *C. eccentrica,* but is larger, with less crowded lamellae, hollow stipe, smaller spores, and the pileus never umbilicate.

CLITOCYBE PUSILLA Peck, Bull. Torrey Club **22**: 199. 1895

Known only from specimens collected by McClatchie on manure at Pasadena, California, February 15, 1895. The type, or at least a portion of it, is in McClatchie's herbarium at the New York Botanical Garden, numbered 879.

CLITOCYBE SINOPICA (Fries) P. Karst. Bidr. Finl. Nat. Folk **32**: 73. 1879

I found this species both in woods and in open fields. Its farinaceous odor was very distinct. The colors of the pileus and stipe were found to vary considerably.

Seattle, Washington, *Murrill 300b, 302, 312, 441, 509, 555, 639;* Corvallis, Oregon, *Murrill 947;* Calaveras Grove, California, *Hutchings 197.*

CLITOCYBE SUBSOCIALIS Peck, Bull. Torrey Club **23**: 411. 1896

Described from specimens collected by Yeomans on grassy ground at Camas, Washington, in December. Peck remarks that it is closely related to *C. socialis,* but differs in its strong odor, squamulose pileus, and white lamellae. The types at Albany very much resemble *C. sinopica,* but Peck says they differ from this species in their squamulose surface, although resembling it in color.

TROPICAL SPECIES OF CLITOCYBE

Six new species of *Clitocybe* from tropical North America were described in *Mycologia* for July, 1911. The list includes *Clitocybe Broadwayi,* from Grenada; *C. incrustata,* from Chester Vale, Jamaica; *C. mexicana,* from Jalapa, Mexico; *C. niveicolor,* from Motzorongo, Mexico; *C. testaceoflava,* from Cinchona, Jamaica; and *C. troyana,* from Troy and Tyre, Jamaica.

Clitocybe rivulosa (Pers.) Quél. was reported from the West Indies by Fries, but no specimens from tropical America have been found in any of the European herbaria. *Clitocybe rubrotincta* (Berk. & Curt.) Sacc., described from Cuba, is probably referable to *Mycena*. There is a large, thick plant at Kew from Cuba bearing the name *Agaricus* (*Clitocybe*) *pachylus* Berk. & Curt., which is probably undescribed.

EUROPEAN SPECIES REPORTED IN AMERICA

Clitocybe aggregata (Schaeff.) Gill. Reported from Rhode Island by Bennett.

Clitocybe angustissima (Lasch) Gill. Reported by Peck as rare in New York.

Clitocybe candida Bres. Reported from New York but doubtless confused with *C. robusta* Peck.

Clitocybe cerussata (Fries) Quél. Reported by Peck as occurring rarely in the Adirondacks, as well as in certain other localities in America.

Clitocybe difformis (Schum.) Gill. Reported once from New York by Peck. It has usually been regarded as a form of *C. cerussata*.

Clitocybe ditopoda (Fries) Gill. Reported by Peck as rare in New York.

Clitocybe ectypa (Fries) Gill. Reported from Alabama by Atkinson.

Clitocybe elixa (Sow.) P. Karst. Reported from Massachusetts and Rhode Island.

Clitocybe fragrans (Sow.) Quél. Reported by Peck as rare in New York. Also reported from North Carolina and California.

Clitocybe geotropa (Bull.) Quél. Reported from Massachusetts, Wisconsin, and California.

Clitocybe hirneola (Fries) Quél. Peck reports it once from New York.

Clitocybe inornata (Sow.) Gill.

Clitocybe obbata (Fries) Quél.

Clitocybe opaca (With.) Gill. Reported from North Carolina by Curtis.

Clitocybe parilis (Fries) Gill. Reported from North Carolina.

Clitocybe pruinosa (Lasch) Quél. Reported from Ohio by Lea.

Clitocybe subinvoluta (Batsch) Sacc. Reported from Massachusetts by Frost and from New York by Peck.

Clitocybe trullaeformis (Fries) P. Karst. Reported from California by Harkness.

Clitocybe tuba (Fries) Gill. Reported by Peck as rare in New York, but his specimens are quite different from European ones.

Clitocybe tumulosa (Kalchbr.) Sacc. Reported from New York once by Peck.

NORTH AMERICAN SPECIES OF MONADELPHUS

MONADELPHUS CAESPITOSUS (Berk.) Murrill, Mycologia 3:192. 1911

Lentinus caespitosus Berk. Lond. Jour. Bot. **6**:317. 1847.
Agaricus (*Pleurotus*) *caespitosus* Berk. Jour. Linn. Soc. **10**:287. 1868.
Agaricus monadelphus Morgan, Jour. Cinc. Soc. Nat. Hist. **6**:69. 1883.
Clitocybe monadelpha Sacc. Syll. Fung. **5**:164. 1887.
Pleurotus caespitosus Sacc. Syll. Fung. **5**:352. 1887.
Clitocybe aquatica Banning & Peck; Peck, Ann. Rep. N. Y. State Mus. **44**:180 (68). 1891.
Armillaria mellea exannulata Peck, Ann. Rep. N. Y. State Mus. **46**:134 (54). 1893.
Clitocybe parasitica Willcox, Okla. Agric. Exper. Sta. Bull. **49**: 18. 1901.

This species has been much discussed both in America and Europe, some claiming that it is distinct and others that it is only a variety of *Armillaria mellea*. Bresadola says it is the same as *Agaricus tabescens* Scop., figures of which appear to be darker throughout than our plant, although very similar. Peck says it differs from *Armillaria mellea* in its decidedly decurrent lamellae, solid stipe, more agreeable flavor, and the absence of an annulus. Both Curtis and Peck considered it edible, but Sterling said it made him very ill on three different occasions and was a dangerous species. It occurs in dense clusters about old stumps from New York to Kansas and south to Alabama and British Honduras, being more common in the southern United States. Specimens at Kew from Cuba bearing this name are entirely distinct.

MONADELPHUS ILLUDENS (Schw.) Earle, Bull. N. Y. Bot. Gard. 5:432. 1909

Agaricus illudens Schw. Schr. Nat. Ges. Leipzig **1**:81. 1822.
Agaricus (*Pleurotus*) *facifer* Berk. & Curt. Ann. Mag. Nat. Hist. II. **12**:421. 1853.
Clitocybe illudens Sacc. Syll. Fung. **5**:162. 1887.

This large and brilliantly colored poisonous species occurs rather commonly in the eastern United States westward to Kansas and Texas in large clusters about stumps and dying trunks of oak and other deciduous trees, and rarely about pine stumps. For a description, illustration, and notes on its poisonous and luminescent properties, see recent numbers of *Mycologia*.

Bresadola considers *Pleurotus olearius,* which occurs on the olive in southern Europe and has been reported by Maire on pine, the same as this species. If this is true, I should be inclined to regard *Pleurotus lampas, Pleurotus noctilucens,* and *Panus incandescens* as also forms of the same widely distributed, highly phosphorescent plant.

Monadelphus marginatus (Peck) comb. nov.

Clitocybe marginata Peck; V. S. White, Bull. Torrey Club **29**: 558. 1902.

Described from specimens found growing in clusters about a decaying stump at Mt. Desert, Maine, in September. There is one plant at Albany and it appears quite distinct. The description, including spore measurements, reminds one of *M. illudens,* with the exception of the color, which is bay-red verging to mahogany. Miss White made an excellent colored sketch of the plant, with notes, which she deposited at the New York Botanical Garden.

Monadelphus revolutus (Peck) comb. nov.

Clitocybe revoluta Peck, Ann. Rep. N. Y. State Mus. **46**: 103 (23). 1893.

Collected once on buried wood in woods at Alcove, New York, and distributed by Shear. It is densely cespitose, with whitish surface and very crowded, narrow, adnate or slightly decurrent lamellae.

Monadelphus sphaerosporus (Peck) comb. nov.

Clitocybe sphaerospora Peck, Bull. Torrey Club **36**: 331. 1909.

Described from specimens collected under oaks at Claremont, California, in January. The species greatly resembles *M. illudens,*

but the spores are about twice as large. It also occurs on eucalyptus.

Sequoia Canyon, Marin County, California, *Alice Eastwood 30;* Stanford University, California, *Dudley 157, Miss A. M. Patterson 12;* Santa Barbara, California, *O. M. Oleson 51, 127.*

NEW YORK BOTANICAL GARDEN.

PENICILLIUM AVELLANEUM, A NEW ASCUS-PRODUCING SPECIES[1]

Charles Thom and G. W. Turesson

Ascus production by species of *Penicillium* is not common. The observations of certain species by Brefeld,[2] Morini[3] and Westling[4] have never been repeated by other workers, some of whom have watched thousands of cultures in the hope of finding one of these forms. On the other hand, *P. luteum* Zukal[5] is a member of a widely distributed group,[6] some members of which have been found repeatedly, while the ascus-producing form is not uncommon. Ascus production in this species is not dependent upon special methods of culture. Another species has now been found by one of us (Turesson) in cultures from the faeces of a bear in the Zoological Garden, at Seattle, Washington. In this form as in *P. luteum,* the asci are produced in almost all of the media regularly used. The time required varies from six weeks to perhaps three months. Its morphology relates it to *P. luteum* and to the ascus-producing forms of *Aspergillus.*

Penicillium avellaneum sp. nov. Thom & Turesson. Colonies upon Czapek's solution agar, broadly spreading, slightly floccose, in conidial areas becoming persistently avellaneous (Ridgeway XL, 17''' 6), producing perithecia slowly during a period of several weeks with the gradual development of aërial hyphae colored Indian-red in the perithecial areas; reverse and agar becoming Indian-red (Ridgway XXVII, 3'' K); conidiophores up to 400 μ long by 3 to 5 μ in diameter, bearing conidial fructifications up to

[1] Published by permission of the Secretary of Agriculture.

[2] Brefeld, O. Bot. Unters, über Schimmelpilze, Heft 2. 1874.

[3] Morini, Fausto. Sulla forma ascofora de Penicillium candidum, Link. Malpighia, anno 2. fascicule 5/6 pp. 224–234. Messina, 1888.

[4] Westling, R. Svensk Botanisk Tidskrift, Bd. 4 (1910), Heft 2, pp. 139–144.

[5] Zukal. Sitz. d. Kais. Akad. d. Wissensch. in Wien, Math. Naturw. Cl., XCVIII, p. 561, 1889.

[6] Thom. C. The Penicillium luteum-purpurogenum group, Mycologia, Vol. VII (1915), no. 3, pp. 134–142.

200 μ long, composed of loosely parallel or tangled chains of conidia; fertile branches either a terminal crowded verticil of metulae 8–10 by 3 μ bearing verticils of few sterigmata 8–9 $\times$ 2 μ, or with branches more or less irregularly disposed over the terminal 10–15 μ of the conidiophore; conidia ellipsoid to almost globose, 2–2.5 $\times$ 3–3.5 μ, smooth, swelling in germination to 5 μ in diameter and producing a single tube.

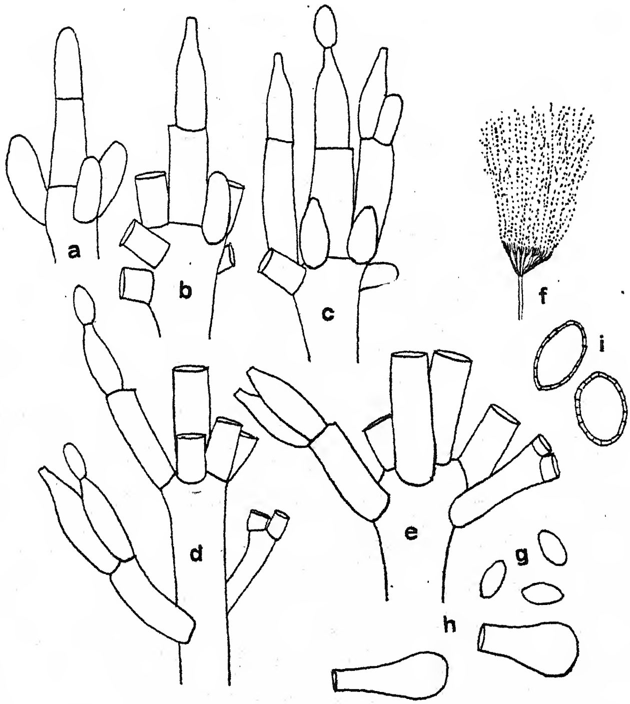


FIG. 1. *a, b, c,* Young conidial apparatus showing variation in branching; *d,* an occasional case of superposed verticils; *e,* a typical single verticillate fruit; *f,* diagrammatic representation of whole conidial fructification; *g,* conidia; *h,* conidia swollen and each producing one germ tube; *i,* ascospores with thick walls apparently fitted; magnification *a, b, c, d, e, g, h, i,* $\times$ 900; *f,* $\times$ 260.

Perithecia ellipsoid to globose 300–600 μ in diameter, originating as an ascigerous mass surrounded by numerous swollen, very thick-walled cells, with the slow development of a peridium composed of thick-walled cells, 8–12 μ in diameter in one or sometimes two layers; asci 9–10 $\times$ 12–15 μ, 6–8-spored; ascospores ellipsoid, 4–5 $\times$ 6.5–8.5 μ, with walls thick, pitted or with the appearance of round, transparent spots.

CULTURAL DATA

Potato agar, good growth, characteristic spreading pink-yellowish colonies.

Potato plugs, rapid and vigorous growth of almost colorless mycelium.

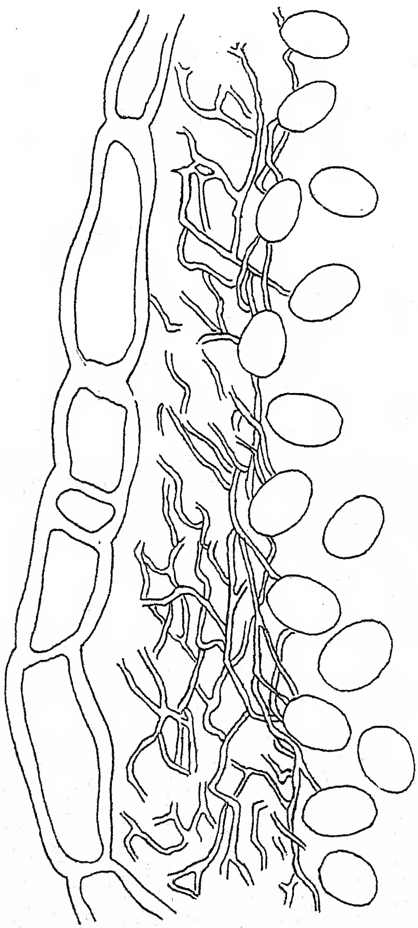


FIG. 2. Wall of perithecium.

Bean agar, feeble growth, floccose yellowish mycelium.

Czapek's solution agar (no nitrogen added), solidified with agar; carbon supplied as:

Cane Sugar, good growth up to 50 per cent. In 60 per cent. feeble, slowly reaching normal proportions.

Galactose 3 per cent., vigorous growth of characteristic colonies.

Lactose 3 per cent., as in galactose, *Levulose 3 per cent.* not vigorous.

Glycerin 3 per cent., fairly good growth; *potato starch,* fair growth.

Butterfat, growth slow; *lactic acid* 0.9 per cent. poor growth.

Fifteen per cent. gelatine in water, good growth, liquefaction beginning within 48 hours at 37° C.; at 27° C. within 3 days, at room temperature after 5 or 6 days.

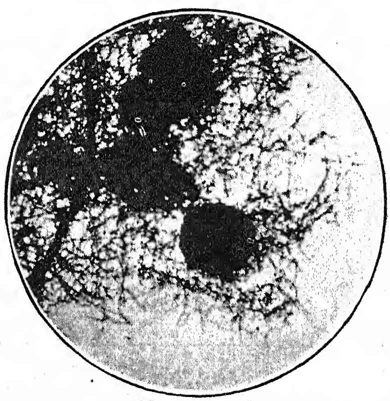


FIG 3. Microphotograph of perithecia by J. Westerberg.

Milk, good growth; curdling beginning on the third day at 37° C.; on the fourth day at 27° C.; on the sixth or seventh at room temperature.

Pigment formation in cultures kept at 27° C. begun on the seventh day in *butterfat* and *potato starch,* slight in the other media. None in *bean agar* at the end of six weeks. At room temperature coloration begun on the tenth day, maximum in *butterfat;* none in *bean agar* at the end of six weeks.

Slow growth at room temperature; fairly good at 27° C.; optimum at 36–38° C.; germination and growth feeble at 42° C.

NEWS AND NOTES

Professor W. C. Coker, of the University of North Carolina, spent several days at the Garden early in August consulting the mycological herbarium and library in preparation of a work on the more conspicuous fungi occurring in the vicinity of Chapel Hill, North Carolina.

Mr. Percy Wilson spent the month of July at Arkville, New York, and obtained a number of interesting specimens of fungi. Arkville is one of the most northerly stations in the local flora range.

Professor H. S. Jackson, formerly head of the department of botany and plant pathology of the Oregon Agricultural College, has recently been appointed chief in botany at the Agricultural Experiment Station, Purdue University, Lafayette, Indiana. Professor Jackson entered upon his new duties at Lafayette on September 1, 1915.

Dr. Lewis Sherman, president of the Wisconsin Mycological Society, died on July 2 from heart disease which developed during the winter. He was not only an enthusiastic and painstaking mycologist, but also had a good general knowledge of botany and knew intimately most of the plants of his region. Mr. Julius Bleyer, assistant editor of "The Evening Wisconsin," succeeds Dr. Sherman as president of the Wisconsin Mycological Society.

Rheosporangium aphanidermatum, a new species and new genus belonging to the Saprolegniaceae, is described by H. A. Edson in the *Journal of Agricultural Research* for July. The fungus is a parasite causing damping off of the seedlings of sugar beets and black rot of radish.

The chestnut canker has been discovered on freshly fallen chestnuts by J. Franklin Collins, who gives a brief account of his dis-

covery and subsequent confirmatory experiments in *Phytopathology* for August, 1915. It is hardly necessary to suggest that this has an important bearing on the introduction of the disease into far distant localities.

A large collection of tough and woody fungi was made in the hammocks of southern Florida by Dr. J. K. Small, Head Curator, during February and March, 1915, including two tropical species new to the United States and two Gulf Coast species new to the subtropical part of Florida. *Favolus variegatus,* locally known as "spirit-cups," was found to occur in great abundance, often reaching a foot in diameter.

Twenty-three new species and several new varieties of fungi from North America are described by P. A. Saccardo in a recent number of *Annales Mycologici.* The fungi listed in the article, of which there are eighty-eight in all from North America, were collected in New York by H. D. House, in Canada by John Dearness, and in North Dakota by J. F. Brenckle.

A memoir of the Torrey Botanical Club issued in June, 1915, consists of a monograph by A. H. Chivers of the genera *Chaetomium* and *Ascotricha.* Twenty-eight species of *Chaetomium,* two of which are new, and two species of *Ascotricha* are described. The memoir contains ninety-five pages of text and is illustrated by seventeen heliotype plates. All of the species are illustrated and the drawings, made by the author, are excellent. The work is a most valuable one for all students of ascomycetes.

A recent paper by J. R. Weir in the *Journal of Agricultural Research* deals with the possible economic importance of *Wallrothiella Arceuthobii,* a fungus which is parasitic on false mistletoe. The fungus has not previously been well known, having been reported only twice and from widely separated localities. The presence of the fungus prevents the maturing of the seeds of the host and in this way tends to retard the mistletoe, which is very destructive to the conifers in the West.

The present season has been exceptionally early and good for fungi of all kinds, owing to the fact that the frost was out of the ground much earlier than usual and the rains have been heavy and frequent. Work on the local fungi by Dr. Murrill has been continuous and many interesting forms, some of them new, have been collected, described, and figured. Dr. Seaver has not only obtained many interesting discomycetes in the vicinity of New York City, but has spent several weeks collecting about Portland, Connecticut.

A New Mephitic Claudopus

Claudopus mephiticus sp. nov.

Pileus eccentric, convex to nearly plane, somewhat depressed at the center, cespitose, 2.5–5 cm. broad; surface dry, glabrous, slightly concentrically sulcate, greenish-white when young, dull-white or yellowish-white when old, margin concolorous, undulate; context white, with a very decided mephitic or garlic odor and taste; lamellae sinuate, subdistant, broad, slightly serrate on the edges, white, becoming rose-colored at maturity; spores angular, rose-colored, uniguttulate, $9 \times 7\,\mu$; stipe short, subcylindric, very eccentric, solid, pruinose, white, 1–1.5 cm. long, 4–6 mm. thick.

Type collected on fallen dead branches in Minnehaha Park, Minneapolis, Minnesota, July 30, 1915, by *Mrs. M. W. Smith.* Complete descriptive notes were made from the fresh specimens by Dr. Mary S. Whetstone, who sent me a copy of them with some of the specimens under her accession number 60. The species seems nearest to *Claudopus depluens,* but is much larger and has a very decided mephitic or garlic odor both in the fresh and dried state. *Claudopus nidulans* is said to have a similar odor, but it must be much less decided and, furthermore, the additional charm of conspicuously angled spores is entirely lacking.

W. A. MURRILL.

Notes on Agaricus reticeps Mont.

An excellent specimen of this plant was sent me in July, 1914, by the late Dr. Lewis Sherman, of Milwaukee, Wisconsin, and I was able to make a careful study of it before it had entirely dried.

The previous summer, I had examined Montagne's type at Paris from Columbus, Ohio, and compared it with specimens sent me by Dr. Mary Whetstone from Minneapolis, Minnesota, and by Dr. Bruce Fink from Oxford, Ohio. The specimens at Albany have also been examined. *Panus meruliiceps* Peck was described from specimens collected by Dr. Glatfelter on trunks of elm trees at St. Louis, Missouri. The original specimens of *Agaricus reticulatus* Johnson, collected on Nicollet Island, Michigan, are lost, but his description clearly refers to the plant under discussion.

The plant occurs sparingly on fallen dead deciduous trunks, especially of elm, in Ohio, Illinois, Kansas, Missouri, Wisconsin, Minnesota, and Michigan; and possibly also in parts of Europe. *Collybia retigera* Bres. is also beautifully reticulate, but is quite distinct.

The proper relationship of this species has been a matter of considerable doubt, as is evidenced by the fact that it has figured in several different genera. The spores are rough but not angular, hyaline, slightly yellowish in mass, assuming a pale-rosy tint on exposure, reminding one of some species of *Pleurotus*. The context is too tough for *Pleurotus, Tricholoma,* or *Clitocybe,* or even for *Collybia,* hence *Lentinula* is probably the best place for it, although the species is aberrant in several particulars.

Lentinula reticeps (Mont.) comb. nov.

Agaricus (*Clitocybe*) *reticeps* Mont. Syll. Crypt. 101. 1856.
Agaricus (*Tricholoma*) *reticulatus* Johnson, Bull. Minn. Acad. 1: 354. 1880.
Agaricus alveolatus Cragin, Jour. Myc. 1: 28. 1885.
Pluteus alveolatus Sacc. Syll. Fung. 5: 679. 1887.
Panus meruliiceps Peck, Bull. Torrey Club 32: 78. 1905.

Pileus fleshy-tough with the cuticle somewhat gelatinous, firm, convex or depressed, cespitose, 3 cm. or more broad; surface glabrous, sometimes viscid, rarely smooth, usually beautifully reticulate with elevated, anastamosing ridges, salmon-colored or pale-brick-red tinged with yellow in the center, margin involute; context pinkish, without characteristic odor, but with a sweetish taste; lamellae fleshy-tough, salmon-colored, adnate or slightly decur-

rent with a tooth, rounded behind, the bases slightly connected, close, narrow; spores globose, echinulate-tuberculate, hyaline, 5–7 μ; stipe tough, glabrous, white to pallid, ochroleucous below, blackish at the base, grooved, central or eccentric, curved, solid, fibrous, 2.5–4 cm. long, 5–12 mm. thick.

W. A. MURRILL.

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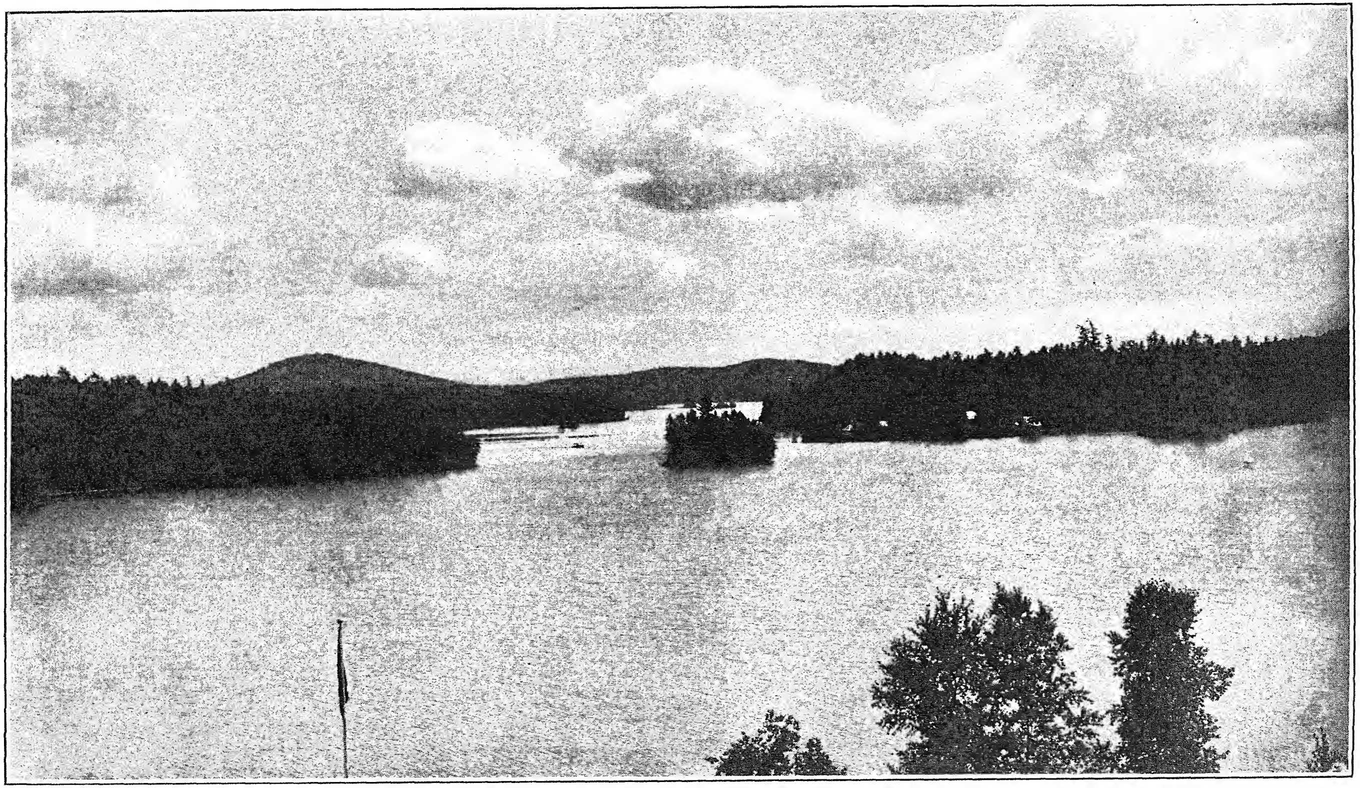


VIEW OF UPPER ST. REGIS LAKE FROM CAMP KANOSA

MYCOLOGIA

VOL. VII NOVEMBER, 1915 No. 6

PRELIMINARY LIST OF UPPER ST. REGIS FUNGI

WILLIAM A. MURRILL

(WITH PLATES 167–169)

It was my good fortune to spend the last week in August, 1915, with Mr. and Mrs. N. H. Luttrell at their camp on the Upper St. Regis, surrounded by virgin forests of balsam fir, spruce, and hemlock, often mixed with birch and rarely with maple and beech.

Fungi were unusually abundant, for it was the height of the season and one of the best years for fleshy forms ever known in the Adirondacks. Every facility was at hand, also, for collecting, drying, and otherwise caring for the specimens; and a dozen friends stood ready to lend me a helping hand.

Under these favorable circumstances, it was deemed advisable to make both a qualitative and a quantitative survey of the more conspicuous fungi appearing in the vicinity during the week, with the hope of assisting the large number of mycologists and other nature lovers who visit the Adirondacks during late summer.

The number of species collected was over 300, and this number might have been largely increased if attention had been given to inconspicuous woody and leathery forms and to species occurring on leaves. A number of the rarer species found have not yet been definitely determined and will not appear in the list to follow.

[MYCOLOGIA for September, 1915 (7: 221–296), was issued September 15, 1915.]

Special attention was given to edible and poisonous fungi. About 35 species were eaten, many of them in quantity and prepared in various ways. Many other edible species were not eaten because the specimens had to be preserved. Those accustomed to the fleshy forms occurring about New York City are entirely unprepared for the remarkable difference in the Adirondack fungous flora, which is distinctly northern unmixed with southern elements and is associated with coniferous forests rather than deciduous woodlands in which oaks and chestnuts are dominant.

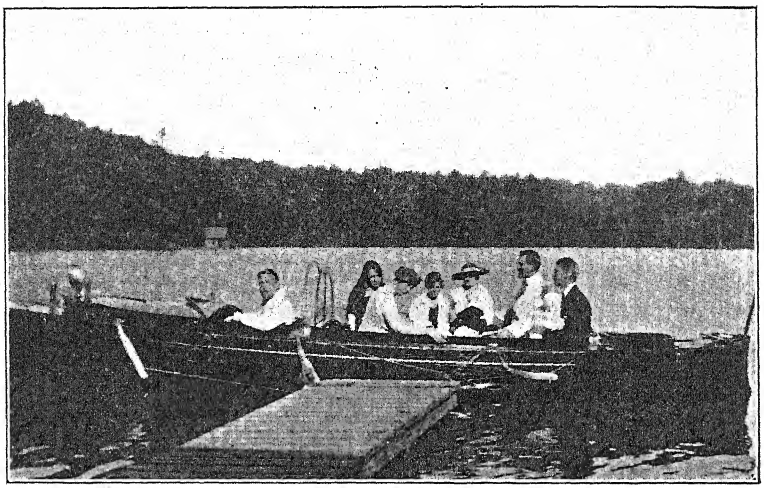


FIG. 1. Landing at Camp Kanosa.

The following list contains a few notes on points of special interest. The abundance of a species is indicated by exponents, the numerals *1–5* denoting a definite number of times collected and the letters *n, nn,* and *nnn* meaning "frequent," "common," and "very common" respectively.

A. MYXOMYCETES

Fuligo septica^{2}
Reticularia Lycoperdon^{2}

B. ASCOMYCETES

Cordyceps militaris.^{1} Found in Isaria form only.
Cudonia lutea^{n}
Daldinia concentrica^{2}
Helvella Infula^{2}

Lachnea hemisphaerica.[2] Very abundant at one place in low mixed woods.
Lachnea scutellata.[2] On dead beech logs.
Leotia lubrica[n]
Macropodium macropus[nn]
Mitrula vitellina[1]
Peziza abietina.[1] Very abundant in one spot in low mixed woods.
Spathularia velutipes[4]
Xylaria polymorpha[n]

C. HYMENOMYCETES

a. TREMELLALES

Tremella lutescens.[2] On hemlock logs.
Tremella mycetophila.[1] On *Collybia dryophila.*
Tremellodon gelatinosum.[1] On coniferous log.

b. AGARICALES

1. Thelephoraceae

Craterellus cornucopioides.[1] Abundant at one spot in the edge of coniferous woods.
Thelephora laciniata[n]

2. Clavariaceae

Members of this family were very abundant everywhere on the ground in the woods. The most abundant species was what I determined as *Clavaria cinerea.* Other species found were:

Clavaria fusiformis[2]
Clavaria pinophila[1]
Clavaria pistillaris[1]

3. Hydnaceae

Members of this family were very rare, as is usually the case. Three species belonging to the *H. zonatum* group were found, but these have not been definitely determined.

Hydnum caput-ursi.[1] On a decaying spot in a living beech trunk.
Hydnum ochraceum[2]

4. Polyporaceae

Bjerkandera adusta[1]
Cerrena unicolor[1]
Coltricia perennis[3]
Coltricia tomentosa[3]
Coriolus abietinus[n]
Coriolus versicolor[n]
Daedalea confragosa[4]
Elfvingia fomentaria[1]
Elfvingia megaloma[n]
Fomes roseus[n]
Fomes ungulatus[n]

Fomitiporia prunicola[1]
Gloeophyllum hirsutum[nn]
Hapalopilus rutilans[1]
Inonotus radiatus[1]
Ischnoderma fuliginosum[n]. The usual form on coniferous logs.
Phaeolus sistotremoides[1]
Piptoporus suberosus[n]
Polyporus elegans[n]
Porodaedalea Pini[n]
Pycnoporus cinnabarinus[1]
Pyropolyporus conchatus[1]
Pyropolyporus igniarius[1]
Scutiger griseus.[1] This was found on a shady bank in coniferous woods. The young pileus was pale-rosy-isabelline, the hymenium white, and the taste mild.
Spongipellis borealis.[1] The specimens were unusually small.
Tyromyces caesius[2]
Tyromyces chioneus[n]
Tyromyces guttulatus[3]
Tyromyces lacteus[2]

5. Boletaceae

Boletinus pictus[nnn]. This beautiful edible species was more abundant than I have ever seen it before. It was difficult to obtain specimens free from insects, even when picked very young.
Ceriomyces affinis[1]
Ceriomyces auriporus[1]
Ceriomyces ferruginatus[1]
Ceriomyces nebulosus?[n]. This rather pretty edible species had been found previously at Lake Placid.
Ceriomyces subglabripes[3]
Ceriomyces viscidus[nn]. Common under birch trees.
Rostkovites granulatus.[5] Two distinct forms of this species were found, the ordinary pinkish form and one which was yellowish throughout, slimy, with a pleasant, slight odor of bitter almonds, a mild taste, and dark-dirty-yellow tubes.
Rostkovites subaureus[nn]. Mostly under pines planted about the camp.
Suillellus luridus.[1] Gregarious at the edge of coniferous woods.
Tylopilus felleus[nnn]. Very conspicuous by reason of its abundance and size. Many specimens were tasted and all were found to be exceedingly bitter.

6. Agaricaceae

Agaricus diminutivus[n]
Chanterel aurantiacus[2]
Chanterel infundibuliformis[nnn]
Chanterel umbonatus[nn]
Claudopus nidulans.[1] At the base of a small dead coniferous trunk. The specimens were young and fresh and were carefully tested by more than one person for a mephitic odor but none was present. I have never noticed such an odor in this species.

Clitocybe clavipes[n]
Clitocybe eccentrica[3]
Clitocybe infundibuliformis[n]
Clitocybe sinopica.[2] On lawn in the open.
Clitocybe subditopoda[2]
Clitocybe virens[2]
Clitocybe spp.
Collybia acervata[nn]
Collybia confluens[nn]. This species has been transferred to *Marasmius*.
Collybia dryophila[nn]
Collybia maculata[nn]. Always spotted and very bitter even when cooked.

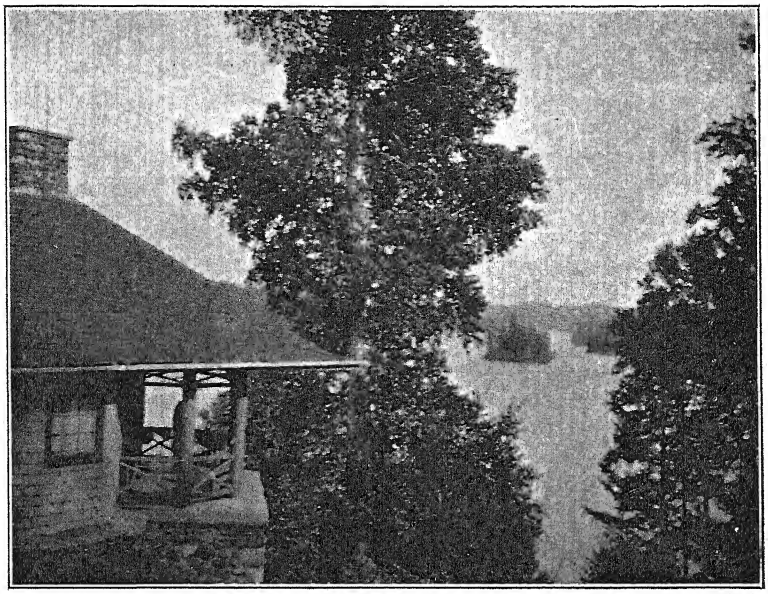


FIG. 2. View of Upper St. Regis Lake from one of the guest houses at Camp Kanosa.

Collybia platyphylla.[2] Under maple and birch.
Collybia radicata.[4] Mostly under beech, attached to the roots.
Collybia scabriuscula[1]
Collybia strictipes?[n]
Collybia tuberosa[n]. On decaying *Lactaria turpis* and possibly other gill-fungi. Several years ago in Maine, I found this species abundant on *Lactaria turpis*.
Collybia spp.
Coprinus fimetarius[1]
Coprinus micaceus.[1] Under birch and maple.
Cortinarius armillatus[nnn]

Cortinarius erythrinus[5]
Cortinarius lilacinus[n]
Cortinarius purpurascens[2]
Cortinarius semisanguineus[nnn]. Attacked by insects when very young.
Cortinarius spp.
Cortinellus rutilans[1]
Entoloma cuspidatum?[1]
Entoloma sericeum[3]
Entoloma strictius?[1]
Entoloma spp.
Flammula penetrans[n]
Flammula sapinea[1]
Flammula spumosa[3]
Galera Hypnorum[2]
Galera tener.[1] On the lawn.
Hygrophorus chlorophanus[1]
Hygrophorus coccineus[n]
Hygrophorus laetus.[1] Several hymenophores of this beautiful species were found in swampy ground between Upper Spectacle and Lower Spectacle lakes.
Hygrophorus miniatus[n]
Inocybe spp. Nearly a dozen species were found, most of them in rather sterile soil in open woods or wood borders.
Laccaria laccata[nn]
Laccaria striatula[n]
Lactaria camphorata[1]
Lactaria deceptiva[nn]. Very large, reaching 8 inches in diameter, dirty-white, cottony on the margin, acrid. This species is found under conifers and takes the place of *Lactaria piperata* found in oak groves about New York City.
Lactaria Gerardii[2]
Lactaria lignyota[nn]
Lactaria mucida[2]
Lactaria oculata[1]
Lactaria parva[1]
Lactaria subdulcis[nnn]
Lactaria theiogala[n]
Lactaria torminosa.[3] This poisonous species may be recognized by its zonate surface and conspicuously woolly margin.
Lactaria turpis.[3] An interesting species, very dull in color, occurring in low places in woods and usually attacked by *Collybia tuberosa*.
Lactaria varia[1]
Lactaria spp.
Lepiota amianthina[5]
Lepiota clypeolaria[n]
Lepiota fuscosquamea.[3] This species is very closely related to *L. clypeolaria*.
Lepiota naucina[1]
Leptonia serrulata[2]
Limacella illinita.[1] Under birch trees.

Marasmius campanulatus[2]
Marasmius oreades.[1] On the lawn.
Marasmius rotula[4]
Melanoleuca albissima[nnn]. Growing gregariously in coniferous woods in large groups covering many square feet and conspicuous at a considerable distance. Many specimens were tasted and all were found to be bitter.
Melanoleuca melaleuca.[2] Found in abundance in one spot at the edge of deciduous woods.

FIG. 3. Some of the guests at Camp Kanosa who assisted in collecting fungi.

Mycena Leaiana[1]
Mycena pura[n]
Mycena spp.
Omphalia campanella[2]
Omphalia chrysophylla[n]
Omphalia fibula[4]

Omphalia umbellifera[1]

Omphalia spp.

Paxillus atrotomentosus[nn]. Very large and more abundant than I have ever seen it before, occurring on stumps in coniferous woods.

Paxillus involutus[nn]

Paxillus panuoides[1]

Pholiota squarrosa.[1] Abundant on a fallen deciduous trunk.

Pholiota spp.

Pluteus cervinus.[2] Only two small specimens were seen.

Russula albidula[1]

Russula compacta[nn]. Large, edible, free from insects.

Russula depallens?[3]

Russula emetica[n]

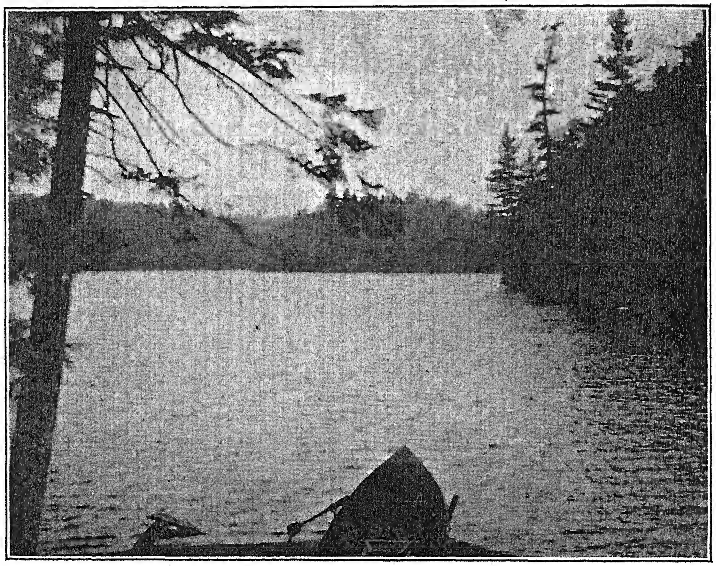


FIG. 4. Lower Spectacle Lake.

Russula foetens[1]

Russula foetens?[n]. More common, somewhat smaller, and with less odor than typical *R. foetens*.

Russula lutea?[n]

Russula spp. A beautiful rosy-stemmed reddish species was common everywhere in coniferous woods and also a purplish species with a white stem. Both of these were edible and easily distinguished from *R. emetica*. Several other species were collected which will be determined later.

Stropharia semiglolata.[2] Found sparingly in its usual habitat.

Vaginata plumbea[nn]. The yellowish form of this species was common everywhere. I do not remember seeing the gray form.

Vaginata plumbea strangulata[n]. I had an excellent opportunity to study this variety in all its stages and, for this locality, it is apparently entirely distinct from *V. plumbea.* It was not found to vary in color, but Professor Atkinson recently told me that he once collected a yellowish form of it.

Venenarius Frostianus[nn]

Venenarius muscarius[n]. The usual orange form of northern latitudes.

Venenarius phalloides[n]. The usual umbrinous form was the common one, just as I found at Lake Placid, while the white form or "destroying angel" was collected only four times. In the vicinity of New York City, the dark form would hardly be noticed during an entire season, while the white form is one of the most abundant fleshy fungi in our woodlands, which accounts for the number of deaths due to its use by ignorant persons.

D. GASTEROMYCETES

Puffballs were not very abundant, if we except *Scleroderma aurantium,* the hard-skinned puffball. In addition to the species listed below, I probably obtained *L. atropurpureum* and *L. pulcherrimum,* as well as two or three other species not definitely determined.

Crucibulum vulgare[1]

Lycoperdon cyathiforme.[1] On the lawn near the camp.

Lycoperdon gemmatum[n]

Lycoperdon pyriforme[2]

Lycoperdon separans.[n] Grassy places in the open.

Lycoperdon subincarnatum.[1] This beautiful species was found in abundance among chips and sticks in a low spot in the edge of mixed woods.

Scleroderma aurantium[nnn]. Abundant everywhere under all kinds of trees.

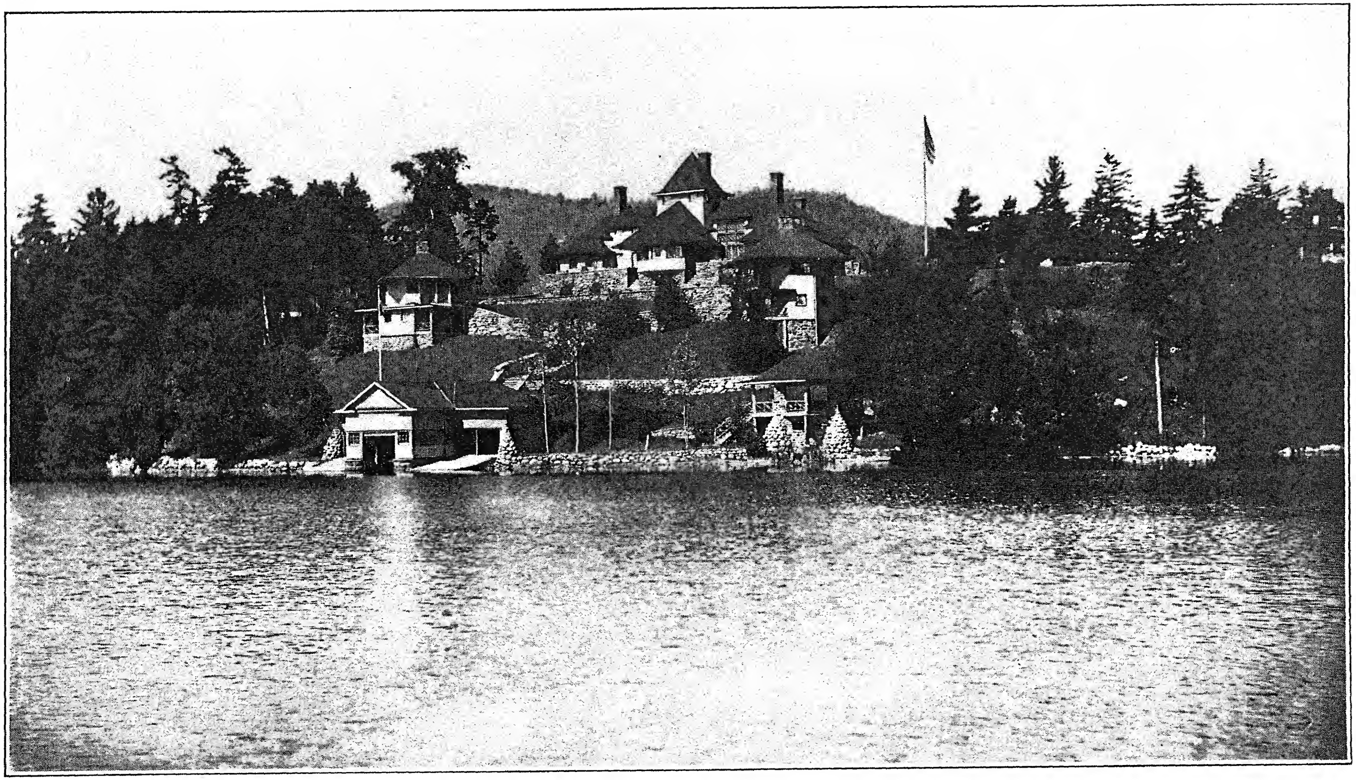
SPECIES USED FOR FOOD

Boletinus pictus
Ceriomyces viscidus
  and several other species
Chanterel infundibuliformis
Chanterel umbonatus
Clavaria, several species
Collybia acervata
Collybia dryophila
Collybia radicata
Cortinarius lilacinus
Cortinarius semisanguineus
Craterellus cornucopioides
Hygrophorus coccineus
Hygrophorus miniatus
Laccaria laccata
Lactaria lignyota
Lactaria subdulcis
  and several other species
Lepiota clypeolaria
Lycoperdon gemmatum
Lycoperdon pyriforme
Lycoperdon Wrightii
Paxillus involutus
Rostkovites granulatus
Rostkovites subaureus
Russula compacta
Russula lutea?
  and several other species
Vaginata plumbea strangulata
Vaginata plumbea

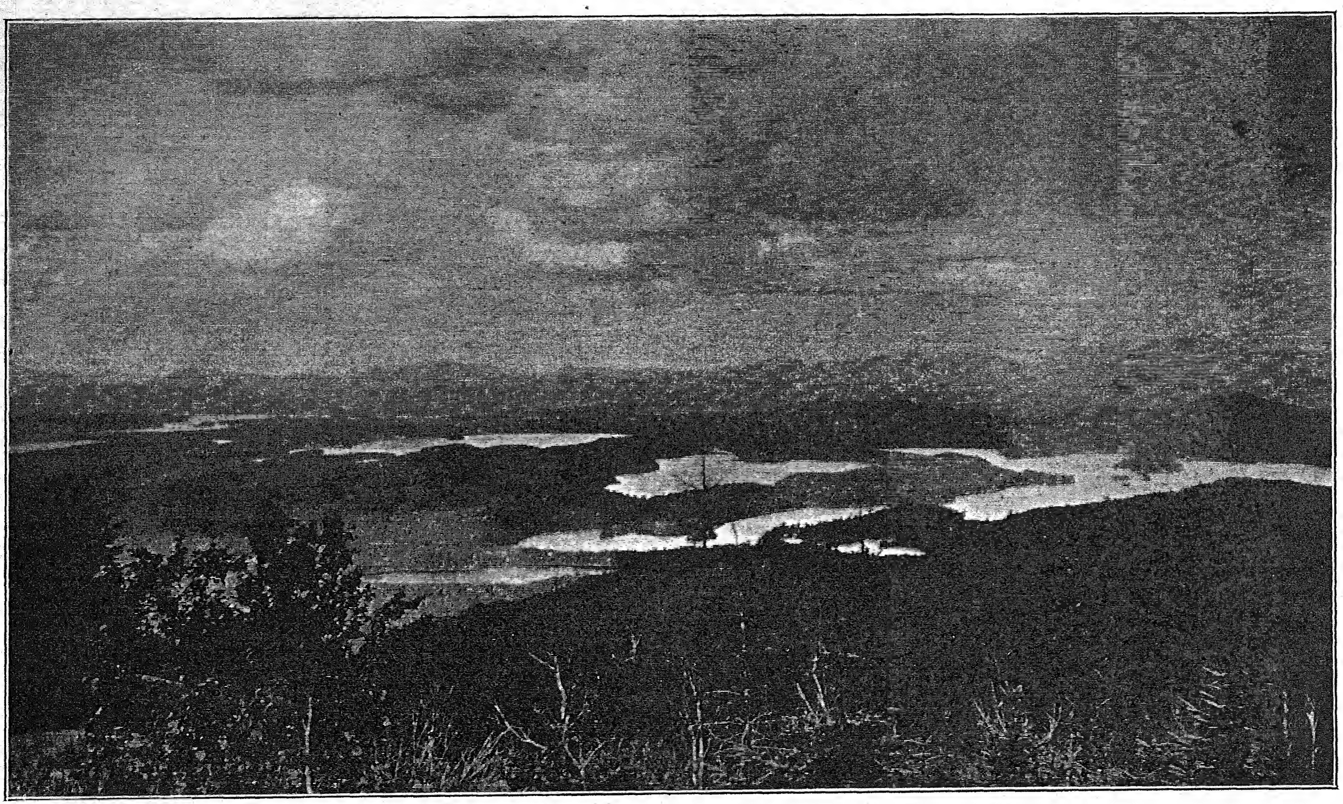
PRINCIPAL POISONOUS AND BITTER SPECIES COLLECTED

Ceriomyces ferruginatus	*Russula foetens*
Collybia maculata	*Suillellus luridus*
Lactaria torminosa	*Tylopilus felleus*
Melanoleuca albissima	*Venenarius muscarius*
Russula emetica	*Venenarius phalloides*

NEW YORK BOTANICAL GARDEN.



CAMP KANOSA WITH ST. REGIS MOUNTAIN IN THE DISTANCE



VIEW OF UPPER ST. REGIS LAKE AND SEVERAL OTHERS FROM ST. REGIS MOUNTAIN. MT. MARCY AND OTHER PEAKS OVER 5,000 FEET HIGH ARE VISIBLE IN THE DISTANCE ON THE RIGHT. CAMP KANOSA IS SITUATED ON THE NARROW RIDGE TO THE LEFT OF THE CENTER BETWEEN UPPER ST. REGIS AND UPPER SPECTACLE LAKES

THE FERAX GROUP OF THE GENUS SAPROLEGNIA[1]

A. J. Pieters

(With Plate 170, Containing 2 Figures)

Nees von Esenbeck ('23) first separated the then known forms of water molds into two genera, *Achlya* and *Saprolegnia,* but, until the time of de Bary's first paper ('52) in 1852, this distinction was not recognized by subsequent workers; de Bary revived the classification of the older author. Meanwhile all forms of water molds had been called *Saprolengia ferax* or *Achlya prolifera,* without any clear distinction being made between these genera. In 1850, Thuret ('50) described the swarm spores of a form that he called *S. ferax* Kütz., and he figured, for the first time, the oogonia. Later de Bary ('81) referred to this figure when he renamed *S. ferax, S. Thureti.*

In 1857 Pringsheim (57) contributed to the literature the description of *S. monoica* with excellent figures; other forms of *Saprolegnia,* those without antheridial branches, he considered as belonging to *S. ferax.* In 1873 he stated that further observation had convinced him that there was no true specific distinction between the forms with an antheridium on every oogonium and those in which the antheridia are almost or quite wanting. They differ, he says, "only in the relative number of antheridia." He therefore grouped all forms of *Saprolegnia* with round, pitted, many spored oogonia into the *"ferax"* group.

In 1881, there appeared a paper by de Bary ('81) in which he united *S. monoica, S. torulosa,* and *S. Thureti* (*S. ferax*) into a group which he called the *ferax* group. He had not yet distinguished *S. mixta.* In his description of *S. monoica,* de Bary followed Pringsheim, but added that in some cases the antheridial branches arise from hyphae remote from the oogonium, or, in other words, are not androgynous.

[1] Contribution from the Botanical Laboratory of the Univ. of Mich. No. 147.

Pringsheim had maintained that if one starts with a form having antheridia and continues the culture for some time, the number of antheridial branches gradually decreases in successive cultures until finally one may have forms without any antheridia. De Bary, however, showed that in his work each form, when secured in a pure culture, maintained its distinctive antheridial characters unchanged and suggested that impure cultures explained Pringsheim's results. Among the members of his "*ferax*" group de Bary distinguished *S. torulosa* by the arrangement of the oogonia in chains, *S. Thureti* (*S. ferax*) by the single large round oogonia, almost none of which have antheridia, and *S. monoica* by the constant presence of androgynous antheridia.

At this time, de Bary did not yet recognize *S. mixta*, nor did he include *S. hypogyna* Pringsheim in the *ferax* group, although this species had been described by Pringsheim in 1873 as a variety of *S. ferax*. In 1888, however, in de Bary's last paper ('88), published after his death, he included in the "*ferax*" group *S. Thureti, S. hypogyna, S. monoica, S. mixta, S. torulosa, S. dioica* (*S. diclina* of Humphrey), and *S. anisospora*. Pringsheim had previously included in the *ferax* group all those forms having smooth, round, pitted, many-spored oögonia, differing only in the number of oögonia accompanied by antheridia. De Bary seems to have departed from the historical conception of the "*ferax*" group and added to it such forms as *S. anisospora* with unpitted oögonium wall, eccentric oöspores and zoöspores of two sizes.

I prefer to follow Humphrey ('92) who limits the "*ferax*" group to *S. ferax, S. mixta,* and *S. monoica,* and these are undoubtedly the forms included under this term by Pringsheim, although he did not recognize *S. mixta* as being distinct from *S. ferax*.

If we turn to the original descriptions to ascertain the limits of the species, we find that in all cases the oögonia are described as round, smooth, and pitted and with a varying number of oöspores. De Bary, indeed, states that the oögonia of *S. Thureti* (*ferax*) are generaly larger than those of *monoica,* but as between *mixta* and *ferax* no distinction based on the oögonia is made. The specific difference, as de Bary plainly states, lies in the number of oögonia accompanied by antheridia, *S. mixta*

having antheridia on about one half of the oögonia, *S. ferax* scarcely ever producing antheridia, while the male organs are found on every oögonium of *S. monoica*. De Bary also calls attention to the fact that the hyphae of *S. mixta* are flaccid and delicate in appearance, while those of the other two species are stiff and strong.

De Bary is very careful to make it clear that *S. ferax* is not wholly without antheridia (see '81, p. 92), and it is because this qualification on the part of de Bary has been sometimes overlooked that we find such statements as that by Kauffman ('08) that *S. ferax* "is said to have *no* antheridia." The formation of oögonia in the empty sporangium cases, thus forming the so-called "cylindrical" oögonia is also not given by de Bary as a character distinctive of *S. ferax*. There doubtless are forms in which this phenomenon occurs more often than in other forms, but the character is of no specific value. Humphrey says of *S. mixta,* "antheridia . . . , absent from a part of the oögonia, sometimes from a large part."

My attention was first called to the question of what is *S. mixta* or *S. ferax* by Kauffman's paper ('08) in which on page 368 he describes a form as *S. mixta,* though 75–90 per cent. of the oögonia were accompanied by antheridia, while on the following page he describes another form in which the male organs were found on only 1 or 2 per cent. of the oögonia. In experiments with the latter form, Kauffman was able to increase the number of antheridia to 25 per cent. of the oögonia but no more. A strict interpretation of the original description of *S. mixta* would exclude both of the forms with which Kauffman worked, as would also be the case with those the writer has collected and on which he found never less than 80 to 90 per cent. of antheridia. Kauffman considered that his form F. must be a form of *S. mixta* because he found antheridia, although he recognizes the difference between his two forms and notes that the hyphae of his form "H." are "rather slender" (p. 368).

Klebs ('99) found that when he grew *S. mixta* in a solution of haemoglobin, no antheridia were produced and this has also been the experience of the writer. On the other hand, Prof. W. C. Coker, of North Carolina, has stated in correspondence with

the writer that in a strain of *S. ferax* which he cultivated, he was able to get from 1 to 95 per cent. of antheridial oögonia, depending on the medium used.

In 1911 I collected at Heidelberg, Germany, a species which I determined as *S. ferax* because I failed to find any antheridia on fly cultures. From time to time I secured antheridia when the fungus was grown in artificial media but not until 1913, having carried the culture to Ann Arbor, did I note antheridia on a fly culture. This led me to question the identification and to reexamine the original material on fly, this having been preserved in alcohol; not one antheridium was to be found.

During that winter I collected a number of cultures from the various dishes of algae kept in the botanical laboratories at the University of Michigan. Each form was isolated by making a single spore culture and a number of these could be referred only to *S. ferax* although in no case were antheridia entirely wanting. To test the matter of the production of antheridia, fly cultures were prepared and kept in a cool room, and the oögonia having antheridia were counted by examining the culture in the dish under a 16 mm. objective and a 12 × eyepiece. With this combination the antheridia can be plainly seen and the culture does not need to be disturbed. The number of oögonia counted and the number with antheridia are recorded in the following table.

Culture No.	Date	Temperature	No. Counted	No. with Antheridia
25	Nov. 19, 1913	Cool (12°–15° C.)	200	11
21F	" 20, "	"	200	19
21F	" " "	Room Temp. (22° + C.)	200	0
28	" 19, "	Cool	100	4
28	" " "	Room Temp.	Many, not counted	0
17	(*S. mixta*)	" "	" " "	90% at least
33	Nov. 20, 1913	Cool	100	1
34	" " "	"	125	3
35	" 23, "	"	100	14
35	" " "	"	100	11
35	" " "	"	100	13

A second culture and count gave the following results:

CULTURE No.	DATE	TEMPERATURE	No. COUNTED	No. WITH ANTHERIDIA
21F	Dec. 9, 1913	Room temp. (22° + C.)	Many	0
21F	" " "	Cool (12°–15° C.)	100	15
21F	" 24, "	Room temp.	80	1 (doubtful)
25	" " "	Cool	100	9
25	" " "	"	100	12
28	" 18, "	"	100	3
28	" 24, "	"	100	3
28	" " "	Room temp.	60	0
33	" 18, "	Cool	100	2
33	" " "	"	100	6
33	" 24, "	Room temp.	100	4
34	" 18, "	Cool	100	2
34	" 24, "	Room temp.	100	7
34	" " "	" "	100	1
35	" 11, "	Cool	100	2
35	" " "	"	100	5
35	" 13, "	Room temp.	100	19
35	" 18, "	Cool	100	7
35	" " "	"	100	7
35	" 24, "	Room temp.	100	5
37	" 18, "	Cool	100	1
37	" " "	"	100	9
37	" 23, "	Room temp.	300	0

The average number of oögonia accompanied by antheridia in cultures grown at a low temperature (about 12° to 15° C.) is shown in the following table:

Culture Number	Average Percentage of Oögonia With Antheridia
21F	8
25	8.8
28	4
33	4
34	2
35	8.4
37	5

In all the cultures cited above, the oögonia were substantially alike, of the same size and pitting, with slight fluctuating variations. The vegetative parts and the sporangia were also alike, but all of these cultures differed strikingly from number 17 which I collected in Germany and number 82, collected at Ann Arbor and which proved to belong to the same species as 17. These two forms had a flaccid delicate mycelium just as de Bary described for *S. mixta* and as Kauffman noted in his culture "H." The pits on the oögonia, though present, were less prominent than on

the oögonia of *S. ferax*, and antheridia, usually of diclinous origin, were found on at least 90 per cent. of the oögonia. It is not impossible that single oögonia of *S. mixta* might be confused with those of *S. diclina* Humphrey, which has diclinous antheridia on round, poorly pitted oögonia, but the latter species, which I collected at Ann Arbor as number 38, has, as de Bary and Humphrey state, the oögonia mostly at the ends of long hyphae, rarely lateral and never racemose, while the lateral racemose arrangement is the rule in *S. mixta*.

While it is probable that mistaken identifications may occur in the study of poor material of several of these species, the case is worst as between *S. ferax* and *S. mixta*. If the almost complete absence of antheridia in the one case and their presence on one half of the oögonia in the other is decisive in these species, then neither of the two forms studied by Kauffman nor those discussed in this paper belong to *S. ferax* or to *S. mixta*. At the same time, there is no doubt that such forms as my numbers 17 and 82 are quite distinct from the others and that numbers 21F, 25, 28, 33, 34, 35, and 37 all belong to the same species. The number of oögonia provided with antheridia may vary in the same form depending on the medium in which it is grown. As already stated, Klebs found that in *S. mixta* the number varied from 0 to 90 per cent., Coker in correspondence, and Kauffman in the paper referred to have also recorded such a variation. In my study of the forms determined as belonging to *S. ferax*, I found that oögonia-bearing antheridia were much more common on the parts of the mycelium near the body of the fly than on the outer portions of the mycelium, and also that the antheridia were much more easily seen when the culture was young than after it had grown rather old. Under the influence of low temperature, there were generally more antheridia than when the culture was kept at room temperature, about 22 degrees Cent. *Saprolegnia monoica* is said to have antheridia of androgynous origin on every oögonium, but when I grew this in 0.05 per cent. haemoglobin solution, the number of antheridia present varied from 0 to 17 per cent. of the number of oögonia. When a mycelium that had previously been grown in pea extract, was transferred to 0.01 per cent. haemoglobin plus $M/200$ levulose, the oögonia were small,

but each one was accompanied by an antheridium and the latter was either diclinous or androgynous. When such a mycelium was transferred to a solution in which the levulose was replaced by an equal concentration of dextrose, the oögonia produced were fewer, but very much larger and not more than 5 per cent. had antheridia. It is evident then that the number of antheridia present may vary with conditions, and that there may also be a natural variability independent of food conditions; the place of origin of the antheridia is also variable. Shall we then go back to Pringsheim's notion and consider these all forms of the same species? To one who has carried many pure cultures of these organisms through several years and who has observed how quite constant each form is under a certain set of conditions, this is out of the question; the forms are different. It is evident that these species make up a group of closely related forms representing tendencies to vary along different lines. Of these, *S. monoica* has the most complete sexuality with antheridia of prevailing androgynous origin; *S. mixta* has less complete sexuality, antheridia of prevailing diclinous origin and a more delicate mycelium; while *S. ferax* represents a complex of forms in which the loss of sexuality has gone much further that it has in the other species. The members of this last subgroup are probably very numerous. There is, of course, no doubt but that the form studied by de Bary was as he described it, almost free from antheridia. The form studied by Coker differed slightly from the ones I had, and Dr. Kauffman has verbally stated that the form he collected as *S. ferax* had many barrel shaped oögonia. Altogether, there seem to be almost as many forms as cultures studied, but all agree in the small number of oögonia found with antheridia. There is no intergradation between the forms with few antheridia and those clearly belonging to *S. mixta,* with one half or more of the oögonia accompanied by antheridia. Furthermore, so far as records go and so far as my own experience goes, the forms with a large number of antheridia have always had the "slender" mycelium first described by de Bary. Until further work throws additional light on this matter I am inclined to believe that all the forms with stiff, strong mycelium and a small number of antheridia on fly cultures at a temperature of 12 to 15 degrees C. must

be called *S. ferax,* while those with weak mycelium and with antheridia on one half *or more* of the oögonia belong to *S. mixta* as described by de Bary.

This merely recognizes the fact that this species is a complex of forms of which de Bary happened to find one, and in this form the loss of sexuality had gone further than in most of the members of the complex.

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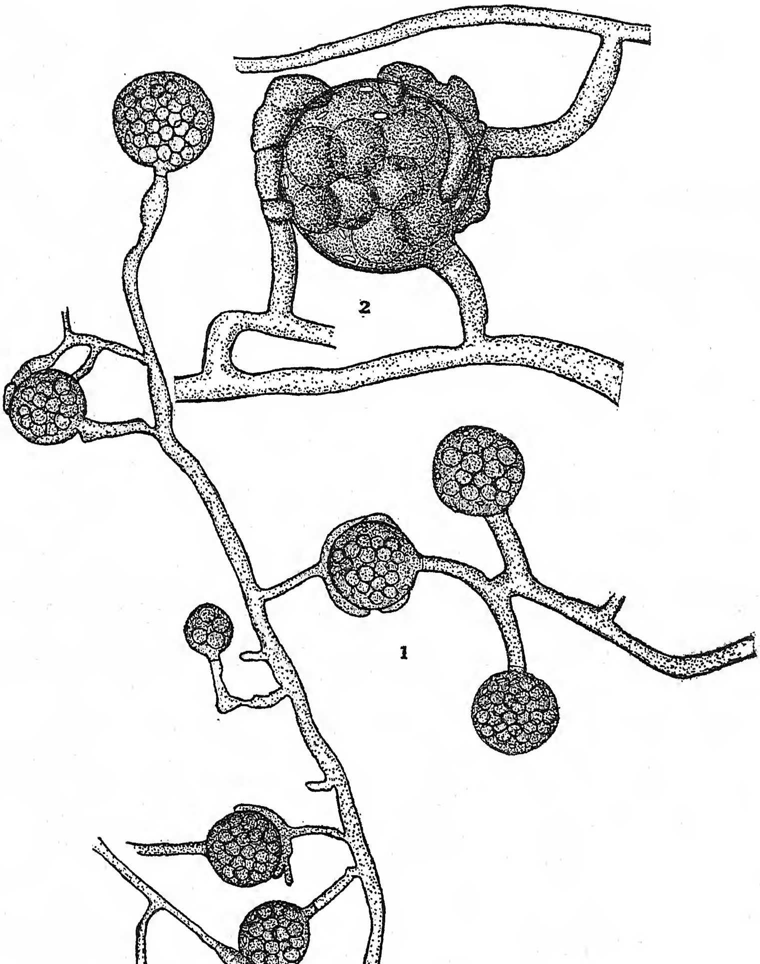
EXPLANATION OF PLATE CLXX

Fig. 1. *Saprolegnia ferax* (Gruith.) Thuret from fly culture in cool window of number 25; showing oögonia with androgynous and diclinous antheridia. × 167.

Fig. 2. Oögonium of *S. monoica* Pringsh. showing androgynous and diclinous antheridia on the same oögonium. × 440.



1. SAPROLEGNIA FERAX (GRUITH.) THURET
2. SAPROLEGNIA MONOICA PRINGSH.

UREDINALES OF PORTO RICO BASED ON COLLECTIONS BY F. L. STEVENS[1]

J. C. ARTHUR

(*Continued from page 255*)

76. **Aecidium abscedens** sp. nov.

Pycnia epiphyllous, numerous on brownish spots 4–9 mm. across, prominent, golden-yellow becoming dark-brown, hemispheric, subcuticular, 140–200 μ broad by about half as high.

Aecia hypophyllous, numerous in crowded groups, cupulate; peridia short, cylindric, 0.1–0.3 mm. in diameter, soon open, coarsely lacerate, somewhat revolute, peridial cells colorless, somewhat overlapping, oblong, 11–16 by 20–37 μ, the outer wall 1.5–3 μ thick, smooth, the inner wall slightly thicker, moderately verrucose; aeciospores broadly ellipsoid or globoid, 18–21 by 20–27 μ wall pale-yellow, thin, 1–1.5 μ, very closely and finely verrucose.

ON RUBIACEAE:

Randia aculeata L., Mayagüez, May 2, *1125;* Cataño, Nov. 3, *4534;* Aguada, Nov. 22, *5089* (type).

A more recent collection, April 25, 1914, comes from Martin Pena, P. R., made by Johnston & Stevens *1886*.

The species is apparently heteroecious. It is markedly different in both gross and microscopic appearance from the Mexican *Aecidium pulverulentum* Arth., which is the only other aecial form known on *Randia,* the publication of the host of the South American *A. Randiae* P. Henn. as *Randia* having been changed to *Basanacantha* (Hedwigia 43: 166. 1904).

77. AECIDIUM BORRERIAE Pat.; Duss, Énum. Champ. Guad. 7. 1903.

ON RUBIACEAE:

Hemidiodia ocimifolia (Willd.) K. Schum., Mayagüez, May 3, *1147*.

[1] Continued from Mycologia 7: 255. 1915.

The species was described from material gathered by Pére Duss in Guadeloupe, and this is the second time it has been recorded.

78. AECIDIUM CIRCUMSCRIPTUM Schw.; Berk. & Curt. Jour. Phila. Acad. Sci. 2: 283. 1853.

Aecidium Cissi Wint. Hedwigia 23: 168. 1884.

ON CUCURBITACEAE:

Cissus sicyoides L., Mayagüez, May 10, 1912, *1bis, 2bis,* April 30, *995b;* San German, Jan. 19, *23a;* Luguillo, March 21, 1912, *65;* Corozal, Feb. 21, *404;* Manati, Nov. 5, *4303;* Aguado, Nov. 22, *5080;* Aguadilla, Nov. 25, *5225;* Jayome Alto, Dec. 3, *5680;* Guayanilla, Nov. 13, *5912;* Jayuya, Dec. 17, *5980;* El Gigante near Adjuntas, Dec. 15, *6012;* Cabo Rojo, Dec. 27, *6454;* River junction below Utuado, Dec. 30, *6505, 6548;* Preston's ranch near Naguabo, Dec. 31, *6759*.

The species on the same host has also been collected in Porto Rico by Underwood & Griggs, at Rio Piedras, June, July, 1901, *238,* and by E. W. D. Holway, at San Juan, Jan. 1911.

Similar specimens have been seen from Jamaica, collected by A. S. Hitchcock, Dec. 1890, G. von Lagerheim, Dec. 1892, F. S. Earle, Oct. 1902, L. M. Underwood, April, 1903, and September, 1906, *3302,* and E. W. D. Holway, Feb. 1915.

In the Schweinitz herbarium at the Philadelphia Academy of Sciences there is an original unmounted packet inscribed in Schweinitz's handwriting "*Aecidium circumscriptum.* Surinam." This is undoubtedly type material. It contains five fragments, belonging originally to three or four leaves. The largest fragment is about 6 by 9 cm., and two other of the fragments can be put together to show that one leaf was originally ovate, deeply cordate and entire, 9 cm. broad by 12 cm. long. About 150 groups of aecia occur on the specimen altogether, in good representative condition. This material has been studied at the New York Botanical Garden and the host pronounced to be *Cissus sicyoides,* Mr. Percy Wilson vouching for the same.

The Schweinitz material in host and fungus agrees closely in

appearance and microscopic detail with the Stevens' Porto Rican material, and with many other collections from other places, which have heretofore been given the Winterian name. The Schweinitz name, being much older, is therefore given preference.

79. AECIDIUM DECOLORATUM Schw.; Berk. & Curt. Jour. Phila. Acad. Sci. **2**: 283. 1853.

Aecidium Clibadii Syd. Ann. Myc. **1**: 333. 1903.

ON CARDUACEAE:

Clibadium erosum (Sw.) DC., Jajome Alto, Dec. 3, *5655*.

The type material in the Schweinitz collection at Philadelphia consists of the larger part of four or five leaves, which originally measured about 16 to 22 cm. long and 10–12 cm. wide. They bear numerous groups of aecia. The inscription in Schweinitz's handwriting reads, "*Aecidium decoloratum*—in foliis an Syng. —Surinam." A likeness was detected between these large composite leaves and those of the Stevens' collection. Through the kindness of the authorities of the Philadelphia Academy of Sciences, it was possible to submit the Schweinitz material to Mr. Percy Wilson of the New York Bot. Garden, who readily ascertained the host to be *Clibadium surinamense* L., a common composite plant of Dutch Guiana.

80. AECIDIUM EXPANSUM Diet. Hedwigia **38**: 258. 1899.

ON CARDUACEAE:

Mikania cordifolia (L. f.) Willd., Coamo Springs, Jan. 1, *90;* Mayagüez, April 30, *995a,* May 1, *1061,* May 2, *1130,* June 13, *2220,* Oct. 31, *3894;* Yauco, Oct. 3, *3126;* Monte de Oro near Cayey, Dec. 3, *3742;* Lares, Nov. 22, *4934, 4935;* Jajome Alto, Dec. 3, *5758;* River junction below Utuado, Dec. 17, *6069,* Dec. 30, *6585, 6873.*

Mikania sp., Villa Alba, Jan. 3, *135*.

No original material of this species has been available for comparison, but the agreement of the Porto Rican material with the description of the Brazilian fungus is remarkably close, the only discrepancy being the slightly smaller spore measurements for

the South American collection, which is well within the limits of laboratory variation.

The species shows a luxuriant and abundant development, and is doubtless heteroecious.

81. AECIDIUM WEDELIAE Earle, Muhlenbergia 1: 16. 1901.

ON CARDUACEAE:

Wedelia trilobata (L.) Hitch. (*W. carnosa* Pers., *Stemmodontia trilobata* Small), Mayagüez, July 27, 1912, *72*, Jan. 15, *283*, April 27, *835*; Cabo Rojo, June 11, *2184*; Utuado, Nov. 8, *4595a*, *4607*; Maricao, Nov. 18, *4704a*; St. Ana, Dec. 31, *6691*; El Gigante near Adjuntas, Dec. 15, *8010*; without locality, Jan. 14, 1914, *6781*.

This form is very common in Porto Rico. Collections from the island have been examined from Mayagüez, by A. A. Heller *4580*, and G. P. Clinton *54*, April 1904, from Utuado by Underwood & Griggs, June–July 1901, from San Juan and Santurce, by E. W. D. Holway, Jan. 1911, from Trujillo Alto, by J. R. Johnston *1042*, August 1913, and from Campo Alegre, by J. A. Stevenson *2475*, Dec. 1915.

Although recorded from other West Indian islands the only specimen examined is from Jamaica, by E. W. D. Holway *213*, Feb. 1915.

It has been suggested by Dr. Stevens that this rust may be the aecial form of *Puccinia canaliculata* on *Cyperus*, which is known to produce aecia on *Xanthium* in the northern United States. The morphological characters favor the suggestion.

FORM GENUS UREDO

Paraphyses absent, mostly forms belonging to *Aecidiaceae*, Nos. 82 to 98.

Paraphyses present.

- Free and peripheral, mostly forms belonging to *Aecidiaceae*, Nos. 99 to 104.
- Imbricated to form a pseudoperidium, forms probably belonging to *Uredinaceae*, Nos. 105 to 108.
- United into a peridium, cellular above, belonging to *Uredinaceae*, No. 109.

82. UREDO PASPALICOLA P. Henn. Hedwigia 44: 57. 1905.

ON POACEAE:

Paspalum conjugatum de Bary, Adjuntas, Nov. 22, *4966*.

This thin-walled, pale-spored rust, which is now reported for North America for the first time, has also been collected in Guatemala, on *Paspalum Humboldtianum,* Jan. 11, 1915, by E. W. D. Holway *64*. The two collections agree closely with the type collection on *P. conjugatum* from Peru, as careful study shows.

83. UREDO DICHROMENAE Arth. Bull. Torrey Club 33: 31. 1906.

ON CYPERACEAE:

Dichromena ciliata Vahl, Mayagüez, April 30, *927*.

Dichromena radicans Cham. & Schl., Guayama, April 6, *847*.

The type specimen of the species was collected on *D. ciliata,* at Mayagüez, April, 1904, by G. P. Clinton. The form was also collected in Jamaica by L. M. Underwood, May, 1903, *2892*.

The form is given for South America by Mayor in his list of Colombian *Uredinales* (Mém. Soc. Neuch. Sci. 5: 581. 1913).

84. UREDO FUIRENAE P. Henn. Hedwigia Beibl. 38: 70. 1899.

ON CYPERACEAE:

Fuirena umbellata Rottb., Santurce, Jan. 22, *253;* Aguas Buenas, Feb. 9, *300;* Mayagüez, April 30, *920*, Oct. 31, *3953;* St. Catalina, Aug. 28, *2743;* Cataño, Nov. 3, *4531*.

This rust was also gathered on the same host at Bayamon, P. R., Jan. 1911, by E. W. D. Holway, and in Cuba, Oct. 1904, by Baker & Wilson *2214,* and March 1907, by F. S. Earle *652*.

The species was described from Brazil on *F. umbellata,* and it has been distributed from India, also on the same host. No teliospores have been found in connection with it. It differs strongly from the uredinia of the *Fuirena* rust in the southern United States, *Puccinia Fuirenae* Cooke, by having two pores, instead of three or four as in that species, and in other characters.

85. URÉDO DIOSCOREAE P. Henn. Hedwigia 35: 255. 1896.

ON DIOSCOREACEAE:

Rajania cordata L., Bayamon, without date, *4162;* Utuado, Nov. 8, *4673;* Jajome Alto, Dec. 3, *5658, 5757;* El Gigante near Adjuntas, Dec. 15, *5948;* River junction below Utuado, Dec. 16, *6030;* St. Ana, Dec. 31, *6687.*

The only other collection of this rust from the West Indies known to the writer was made by E. W. D. Holway in Cuba, March, 1903. The Holway collection is not on *Rajania,* but on some undetermined species of *Dioscorea.* The spores of the Cuban material resemble those of the type, which was on *Dioscorea grandiflora* from Brazil, but appear slightly thinner walled, and a little more coarsely verrucose. All the Stevens' collections agree with the Cuban material, except that no. *5948* does not appear to vary at all from the type collection. The variations noted seem unimportant. Pore characters could not be determined, but the arrangement is probably equatorial.

86. UREDO NIGROPUNCTATA P. Henn. Hedwigia 35: 254. 1896.

ON ORCHIDACEAE:

Bletia patula Hook., Maricao, April 3, *804a, 826.*

The species occurs on phanerogamic specimens in the N. Y. Bot. Garden of the same host from Cuba, March, 1903, Underwood & Earle *929,* and on *Bletia purpurea* (Lam.) DC. from Hayti, Aug., 1903, Geo. V. Nash *706,* and from the Bahamas, March, 1907, L. J. K. Brace *7011,* and Feb., 1910, Small & Carter *8876.*

87. UREDO ERYTHROXYLONIS Graz. Bull. Soc. Myc. Fr. 7: 153. 1891.

ON ERYTHROXYLONACEAE:

Erythroxylon areolatum, L., Mona Island, Dec. 20, 21, *6148, 6448.*

The species has been collected in Prov. Havana, Cuba on *E. havanense* Jacq. in 1904, by C. F. Baker *4127* (Barth. Fungi Columb. *2287*), the host having recently been determined by Mr.

Percy Wilson of the N. Y. Bot. Garden. It was also collected in Prov. Pinar del Rio, Cuba, on a phanerogamic specimen of *E. havanense,* Dec., 1911, by Percy Wilson *11569*.

The spores of the two Porto Rican collections measure 16–20 by 21–27 µ, and largely are cinnamon-brown above and paler in color below. Most collections of the rust seen by the writer, and especially those on the same host as the type, *E. Coca,* have larger spores, 18–23 by 24–32 µ, which are concolorous. In a collection made by J. N. Rose *18916,* in Bolivia, Aug. 16, 1914, only about half of the spores are paler below. In some sori taken from a phanerogamic specimen of *E. areolatum 6449,* in the N. Y. Bot. Garden, with the same data as no. *6448* above, many spores measure quite as long as those found on *E. Coca.* It may be assumed, therefore, that variation in size and color of spores is incidental.

88. UREDO HYMENAEAE Mayor, Mem. Soc. Neuch. Sci. 5: 585. 1913.

ON CAESALPINIACEAE:

Hymenaea Courbaril L., Joyuda, March 31, *962;* Mayagüez, May 3, *1157,* Oct. 31, *3897, 3901;* Añasco, Sept. 21, *3210,* Oct. 12, *3575*; Vega Baja, Nov. 5, *4324*.

This rust was described from Colombian material on an undetermined species of *Hymenaea*. Dr. Stevens's fine set doubtless makes the second lot to be collected. The rust exhibits characteristics of the subfamily *Raveneliatae,* in the elongated spore with equatorial pores.

89. **Uredo lutea** sp. nov.

Uredinia hypophyllous, abundantly scattered or in small groups on discolored spots, pustular, 0.3–0.7 mm. across, long covered by the brown overarching epidermis, finally sparingly pulverulent, subepidermal; paraphyses none; urediniospores pedicillate, irregularly ellipsoid or obovoid, 19–21 by 26–29 µ; wall cinnamon-brown, about 1.5 µ thick, moderately echinulate, the pores usually indistinct, 2 or rarely 3, equatorial.

ON CAESALPINIACEAE:

Cassia quinquangulata L. C. Rich., without locality or date, *404bis;* Maricao, April 4, *704;* Jayome Alto, Dec. 3, *5653;* Preston's ranch near Naguabo, Dec. 31, 6762.

This rust presents few salient features, either in the sorus or the spores. The host and the lack of any debarring characters would indicate that it belongs under *Ravenelia.* It does not, however, accord with any known species of that genus so far as can be ascertained.

90. UREDO ARACHIDIS Lagerh. Tromsö Mus. Aarsh. **17**: 106. 1894.

Uromyces Arachidis P. Henn. Hedwigia **35**: 224. 1896.

ON FABACEAE:

Arachis hypogea L., Dorado, Nov. 25, *5318, 5319.*

The two collections by Stevens are the only ones from the West Indies known to the writer. The rust is probably not rare, however, as I have found at the N. Y. Bot. Garden that it occurs on a phanerogamic specimen of *A. hypogea* from Grenada, W. E. Broadway, Oct., 1905, and on one from Guadeloupe, Pére Duss *3581*, Dec., 1894.

A species of *Uromyces* has been described for this host from Surinam by Hennings, but the type material is said by Sydow (Monog. Ured. **2**: 346. 1910) to show only urediniospores. A species of *Puccinia* on the same host was described by Spegazzini in 1884 (An. Soc. Ci. Arg. **17**: 90) no material of which has been seen. There is no mention of urediniospores, and the relationship with material in hand is problematical.

91. UREDO CABRERIANA Kern & Kellerm. Jour. Myc. **13**: 25. 1907.

ON FABACEAE:

Erythrina glauca Willd., Bayamon, Feb. 23, *386,* Feb. 20, *441,* June 23, *2498,* without date, *4096.*

Porto Rican collections have been made on the same host at Rio Piedras, by J. R. Johnston *1099,* and J. A. Stevenson *2345,* and at Bayamon, Jan., 1911, by E. D. W. Holway.

It has been collected on the same host in Cuba as part of a phanerogamic specimen, in 1906, by Abarca & O'Donovan *2634,* communicated by Percy Wilson.

The type collection came from Guatemala. The host of the

type was determined by Capt. J. Donnell Smith as *Buettneria lateralis,* but after the Stevens' collections came to hand the original material was again submitted to Capt. Smith who found that through some error it had been wrongly reported, and was in fact *Erythrina glauca.* The Holway collection from Cuba was first said to be on *E. micropteryx,* which is clearly an error.

92. UREDO CUPHEAE P. Henn. Hedwigia 34: 99. 1895.

ON LYTHRACEAE:

Cuphea Parsonsia R. Br., Cabo Rojo, June 15, *2279.*

This is the first collection of this rust in North America. The gross and microscopic appearance of the Porto Rican material agrees perfectly with that of the type, which was collected at Goyaz, Brazil by E. Ule *2001,* on an undetermined species of *Cuphea.*

93. **Uredo fallaciosa** sp. nov.

Uredinia hypophyllous, irregularly gregarious on somewhat discolored spots, roundish, 0.1–0.5 mm. across, tardily naked, pulverulent, fuscous; urediniospores ellipsoid or obovoid, 18–23 by 24–29 μ; wall pale yellow or slightly fuscous, 1–1.5 μ thick, moderately echinulate, the pores obscure.

ON RUBIACEAE:

Psychotria patens Sw., Maricao, April 3, *774* (type); Ponce, Nov. 8, *4341.*

The uredinia are not abundant in these collections. The sori are not prominent on the leaf surfaces, merely making an inconspicuous roughening that attracts attention chiefly by the slight discoloration. The sori are subepidermal, without paraphyses, and have the aspect of forms belonging to species of *Uromyces* and *Puccinia.* Three rusts with uredinia have been described by Hennings from South America, but in the absence of material for examination it is not possible to say if any of them include the Porto Rican form.

94. **Uredo sabiceicola** sp. nov.

Uredinia largely hypophyllous, scattered singly or in groups of 2–5 on small discolored spots 0.5–1 mm. across, round, small, 0.1–0.3 mm. in diameter, dull cinnamon-brown, subepidermal;

paraphyses peripheral, numerous, incurved, clavate, stout, 10–12 by 19–23 μ, the wall colorless, thin, 0.5 μ, somewhat thickened on the outer curved part, 1.5–2 μ, smooth; urediniospores obovoid, 16–23 by 25–29 μ; wall golden-yellow, thin, 1 μ, moderately verrucose-echinulate, the pores obscure.

ON RUBIACEAE:

Sabicea aspera Aubl., Mayagüez, May 1, *1047*.

This distinctive rust with its conspicuous paraphyses is evidently not the same as *Uredo Cephalanthi* Arth., which is without paraphyses. There appears to be no other form known that is at all closely related.

95. **Uredo proximella** sp. nov.

Uredinia chiefly hypophyllous, crowded in groups 2–4 mm. across, bullate, roundish or irregular, large, 0.3–0.9 mm. across, tardily naked, cinnamon-brown, pulverulent, ruptured epidermis conspicuous as a partial membranous covering; urediniospores broadly ellipsoid or obovoid, 18–20 by 19–24 μ; wall cinnamon-brown, thin, 1–1.5 μ, closely and finely echinulate, the pores rather indistinct, 4–6, scattered.

ON CICHORIACEAE:

Lactuca intybacea Jacq., Sabana Grande, March 30, *318*.

In the characters of both sori and spores this species bears considerable resemblance to the uredinia of *Puccinia hemisphaerica* (Peck) Ellis & Ev. It has been detected on specimens in the phanerogamic collection of the N. Y. Bot. Garden from St. Domingo, March, 1913, Rose, Fitch & Russell *4015*, and from Cuba, March, 1909, N. L. Britton *2161*.

96. UREDO BIOCELLATA Arth. Bull. Torrey Club 33: 517. 1906.

ON CARDUACEAE:

Pluchea odorata (L.) Cass., Ponce, Dec. 4, *5393;* Vega Baja, Feb. 22, *360a*.

Pluchea purpurascens (Sw.) DC., Santurce, May 21, *1799;* Cabo Rojo, Sept. 28, *3186;* Mona Island, Dec. 20, 21, *6198*.

The species was also found in the phanerogamic herbarium of the N. Y. Bot. Garden on *P. odorata,* collected at Guanica, P. R., Jan., 1899, by C. F. Millspaugh *713*.

In the same herbarium it occurs on *P. purpurascens* from St. Domingo, collected March 1913, by Rose, Fitch & Russell *4294*.

Heretofore the species has only been known from southern Florida.

97. **Uredo vicina** sp. nov.

Uredinia hypophyllous, scattered, round, 0.3–0.5 mm. across, soon open, dark cinnamon-brown, pulverulent, ruptured epidermis evident; urediniospores globoid, often flattened above, 24–29 μ in diameter; wall chestnut-brown, 1.5–2 μ thick, closely echinulate, the pores 4, equatorial.

ON CARDUACEAE:

Wedelia lanceolata DC., Guanica, Feb. 3, *365*, Feb. 10, *365bis* (type).

The spores of this species are entirely unlike the urediniospores of *Uromyces pianhyensis*, on another species of *Wedelia*, especially in size and in having decidedly thicker walls with more pores that are clearly evident.

98. UREDO SPARGANOPHORI P. Henn. Hedwigia 43: 160. 1904.

ON CARDUACEAE:

Struchium Sparganophorum (L.) Kuntze (*Sparganophorum Vaillantii* Gärt.), Mayagüez, April 29, *523*, April 30, *911*.

Although the leaves were well covered with uredinia, no trace of telia or aecia could be found. The same rust was detected in the phanerogamic collection of the N. Y. Bot. Garden on the same host from Green Island, Jamaica, March, 1908, Wm. Harris *10254*.

99. UREDO GYMNOGRAMMES P. Henn. Hedwigia 34: 337. 1895.

ON POLYPODIACEAE:

Dryopteris Poiteana (Bory) Urban, Villa Alba, Jan. 3, *86*.

The same fungus was collected in Jamaica on *Dryopteris patens* (Sw.) Kuntze, May, 1903, by L. M. Underwood *2869*, and in Cuba, on *Pityrogramma calomelaena* (L.) Link, March, 1903, by E. W. D. Holway.

Uredo superficialis (Speg.) Lagerh., a very similar fungus, was collected in Jamaica on *Anemia hirsuta* (L.) Sw., Feb., 1903, by L. M. Underwood *1170*.

Both of these forms on ferns are to be included under the *Uredinales* with considerable doubt, on account of the form of the sorus. They need to be studied cytologically and also as to their development.

100. **Uredo Stevensiana** sp. nov.

Uredinia chiefly epiphyllous, scattered or in small groups on discolored spots, elliptical, small, 0.2–0.5 mm. long, brownish-yellow, rather tardily naked by a longitudinal rupture of the epidermis; paraphyses numerous, chiefly peripheral, erect or incurved, clavate, 10–15 by 29–50 μ, the wall colorless, thin, about 1 μ, somewhat thicker above, 2–4 μ; urediniospores ellipsoid, 16–21 by 23–27 μ; wall pale-yellow or colorless, thin, 1–1.5 μ, closely and rather prominently echinulate, the pores indistinct.

ON POACEAE:

Axonophus compressus (Sw.) Beauv. (*Paspalum compressum* Rasp.), Mayagüez, Jan. 9, 1913, *237*, Feb. 8, *280*, April 30, *923*.

Paspalum Humboldtianum Flügge, Cuernavaca, Mex., Sept. 28, 1899, E. W. D. Holway *3510* (type).

Paspalum paniculatum L., Vega Baja, Feb. 22, *373*.

Paspalum (? *Helleri* Nash), Mayagüez, April 30, *932*.

Paspalum plicatulum Michx., Mayagüez, April 30, *943*.

This grass rust differs from *Uredo paspalicola,* which it closely resembles in general appearance, by the presence of numerous paraphyses and the somewhat smaller spores. The collections made by Dr. Stevens are the only ones seen or known from the West Indies, or in fact from any locality, except the one collected by Holway from central Mexico. The Mexican collection is ample, the rust well displayed and free from parasites, and is therefore chosen for the type of the species. The Stevens' collections are less ample, and the rust much parasitized. But it was the varied material supplied by Dr. Stevens that made it possible to delimit the species, and to him rightly belongs the honor implied in the proposed specific name.

101. **Uredo rubescens** sp. nov.

Uredinia hypophyllous, irregularly grouped on indefinite pale spots, round, small, 0.2–0.4 mm. across, soon naked as if by a central pore, surrounding epidermis scarcely noticeable except for a reddish coloration, subepidermal; paraphyses peripheral, cylindrical, hyphoid, incurved, scarcely rising above the spore-mass, the wall colorless and smooth; urediniospores ellipsoid, 18–19 by 25–28 μ; wall pale cinnamon-brown, 1.5 μ, rather closely and strongly echinulate, the pores obscure.

ON MORACEAE:

Dorstenia Contrajerva L., Camuy, Nov. 22, *5011*.

A well marked form. Although the paraphyses are not readily found except by sectioning, yet they are indicated under a hand lens as a pale circle bounding the sorus. The spores either have very short pedicels or are formed in chains, of which only one spore matures at a time. Even the best sections do not decide the matter, but it must be left to be worked out from a study of the cytological development.

102. **Uredo Bixae** sp. nov.

Uredinia epiphyllous, numerous, scattered singly or in groups of two to four on small purple spots, very small, about 0.1 mm. across, soon uncovered, ruptured epidermis inconspicuous, the paraphyses showing as a whitish circle, subepidermal; paraphyses peripheral, numerous, incurved, rising but little above the surface of the leaf, clavate-cylindric, 9–10 by 27–35 μ, the walls colorless, smooth, less than 1 μ inside and 2–5 μ outside; urediniospores obovoid, 16–23 by 26–37 μ; wall nearly colorless, thin, 1 μ or less, closely and finely echinulate, the pores obscure.

ON BIXACEAE:

Bixa Orellana L., Adjuntas, March 2, *462*.

The host is a native of tropical America, but has been cultivated and become wild in tropical regions throughout the world. It supplies the coloring matter of commerce called annatto, much used in butter.

The sori are very small, numerous and deep-seated, but in the specimen examined, they are much parasitized and the spores few.

103. UREDO CAPITULIFORMIS P. Henn. Hedwigia 34: 97. 1895.

Ravenelia capituliformis P. Henn. Hedwigia 43: 160. 1904.

ON EUPHORBIACEAE:

Alchornea latifolia Sw., Luguillo forest, Dec. 2, *5437*; Preston's ranch near Naguabo, Dec. 31, *6669*.

This is the first record of the occurrence of this species in North America. The type collection was made by E. Ule *3060*, at Goyaz, Brazil, and shows an abundance of the very peculiar uredinial sori. These sori arise from under the cuticle from a minute hymenial layer. They expand into a globular, brown capitulum, seated lightly on the surface of the leaf and composed of incurved, thick-walled, dark-brown paraphyses, holding a small number of spores. The appearance under a low magnifying power is much like that of the fruit of some *Erisyphe* or other Perisporiaceous fungus. The spores are equally remarkable with the sori in possessing four bulging protuberances in the upper half of the generally obovoid spore, and a similar apical protuberance. The wall of the spore is cinnamon-brown, 1–1.5 μ thick, and closely echinulate. The pores can not be located.

In these characters the rust collected by Stevens in Porto Rico agrees perfectly. In addition, however, both the Stevens' collections show well formed pycnia and aecia. The pycnia are conspicuous, epiphyllous, in small groups, mamilliform, subcuticular but depressing or absorbing the epidermal cells, 100–165 μ across; ostiolar filaments apparently wanting. The aecia are amphigenous, gregarious, more abundant on the upper surface of the leaf surrounding the pycnia. They are subepidermal, with the adjoining epidermal cells greatly elongated to form a cone about the mouth of the aecium. A persistent peridium barely protrudes beyond the leaf-surface, and the structure can not be determined with dried material. The aeciospores are catenulate with intercallary cells. They closely resemble the remarkable urediniospores in form, color and markings, but the echinulation, if such it is to be called, is considerably coarser. The finest points appear like those on the urediniospores. The points are, however, mostly conspicuously hyaline, acute warts, although their bases are too narrow for them to be unreservedly called verrucose.

The peculiar appearance of the uredinia led Hennings to place this rust in the genus *Ravenelia,* but the discovery of the aecia makes this more ill advised than at first. When the telia are found, it is more likely to constitute a new genus, or to belong to a little known one.

In the phanerogamic collection at the N. Y. Bot. Garden, pycnia and aecia were found on *A. latifolia* from island of Tortola, 1913, J. A. Shafer *1148.*

104. UREDO GOUANIAE Ellis & Kelsey, Bull. Torrey Club 24: 209. 1897.

ON FRANGULACEAE (RHAMNACEAE):

Gouania lupuloides (L.) Urban (*G. domingensis* L.), Jajone Alto, Dec. 3, *5685;* Aguadillo, Nov. 22, *5701;* San German, Nov. 8, *5791.*

Gouania polygama (Jacq.) Urban (*G. tomentosa* Jacq.), Guanica, Feb. 3, *328.*

This form is distinguished from the uredinia of *Puccinia Gouaniae* Holw. by the reniform spores with one lateral pore. Whether this morphological difference indicates a true specific distinction, or only a racial one, is not likely to be decided until teliospores of this form are found, and possibly not until the full life cycle of both forms is known.

The collections by Dr. Stevens are the only ones known to the writer except the type collection made by A. E. Ricksecker in St. Croix, Jan., 1896.

105. UREDO COMMELYNEAE Kalchbr. Grevillea 11: 24. 1882.

ON COMMELINACEAE:

Commelina virginica L. (*C. elegans* H. B. K.), Coamo Springs, Nov. 13, *3981.*

So far as the writer knows, this species of rust has heretofore only been known from the type collection, made at Port Natal, South Africa. Through the kindness of the Director of the Kew Gardens, I have been able to study a portion of the original material from the Kew Herbarium, and find that it agrees perfectly with the material collected by Dr. Stevens. Hoping to

secure further knowledge of so rare a tropical form, I appealed to Mr. Percy Wilson to look at specimens in the phanerogamic herbarium at the N. Y. Bot. Garden. Mr. Wilson found three collections with an abundance of the rust. They are all three on *C. virginica,* two from Porto Rico, Arecibo, Jan. 27, 1899, Mr. & Mrs. A. A. Heller *357,* Sabana Llana, Nov. & Dec., 1899, George P. Goll *164,* and one from St. Thomas, Feb., 1887, *Eggers.*

This species differs in a very marked way from the uredinia of *Uromyces Commelinae,* in having smaller and nearly colorless spores with thin walls, and especially in possessing a paraphysoid peridium opening by a central pore, similar to that described under *Uredo concors.*

106. UREDO AESCHYNOMENIS Arth. Bot. Gaz. 39: 392. 1905.

Physopella (?) *Aeschynomenis* Arth. N. Am. Flora 7: 104. 1907.

ON FABACEAE:

Aeschynomene americana L., Mayagüez, Oct. 31, *3945;* Ponce, Nov. 8, *4356;* Maricao, Nov. 18, *4798;* Rosario, Nov. 14, *4842;* Utuado, Nov. 8, *4581ab;* Aguada, Nov. 22, *5074.*

The species was described from Mexican material. A collection from Caracas, Venezuela, was subsequenlty communicated to the writer by W. G. Farlow. It is also reported by Mayor (Mém. Soc. Neuch. Sci. 5: 587. 1913) from Colombia. Mayor also reports the species from the same region on *A. sensitiva* Sw.

The uredinia only are known. They possess a strongly developed pseudoperidium composed of imbricated paraphyses, a character not consistent with typical species of *Physopella.* The species is, therefore, listed here under *Uredo.*

107. **Uredo concors** sp. nov.

Uredinia hypophyllous, in small groups on discolored usually reddish spots, mammillose, small, 0.1–0.3 mm. across, finally opening by a small central pore; paraphyses united by their bases and internally imbricated to form a pseudoperidium, colorless to golden-brown, the free ends clavate, with moderately thick and

smooth wall; urediniospores ellipsoid or somewhat obovoid, 15–21 by 19–28 μ; wall nearly or quite colorless, thin, 1.5 μ, closely and finely verrucose-echinulate, the pores obscure.

ON FABACEAE:

Dolichos Lablab L., Jayuya, Dec. 17, *6042* (type).

Teramnus uncinatus (L.) Sw., Jayuya, Dec. 17, *5998*.

The *Uredo Teramni* Mayor differs greatly from the above species in having a sorus without paraphyses, and in having globose, 2-pored spores.

108. **Uredo jatrophicola** sp. nov.

Uredinia hypophyllous, crowded on slightly discolored spots or evenly scattered, bullate-conical, small, 0.1–0.3 mm. in diameter, long covered by the overarching epidermis, opening by a central pore that gradually enlarges; peridium paraphysoid, the paraphyses clavate with the slender stalks firmly united into an enclosing wall, and with the heads, 9–12 μ broad, imbricately projecting into the cavity of the sorus, the largest ones at the orifice, the wall smooth, about 1 μ thick and colorless below, about 3–7 μ and tinted above; urediniospores ellipsoid or obovoid-ellipsoid, 16–20 by 24–29 μ; wall very pale yellow or colorless, thin, 1–1.5 μ, rather closely and finely echinulate; pores not discernible.

ON EUPHORBIACEAE:

Jatropha Curcas L., Hormigueros, Jan. 14, *220* (type).

Jatropha gossypifolia L., San German, Dec. 8, *4113, 4790;* Guayama, Dec. 4, *5401;* Guayanilli, Nov. 13, *5866bis*.

The species has also been detected on phanerogamic specimens: on *J. Curcas,* St. Domingo, March, 1913, Rose, Fitch & Russell *4064;* on *J. gossypifolia,* Cuba, April, 1903, J. A. Shafer *86*, March, 1910, Britton & Wilson *5549,* St. Croix, Feb., 1913, Rose, Fitch & Russell *3204*.

The paraphysoid peridium and pale spores make a marked distinction between this and other known rusts on Euphoriaceous hosts. Small subepidermal sori were found on the two Cuban specimens that appeared like compact, lens-shaped telia, beneath the epidermis, with small, smooth, thin-walled spores, but they were very few and uncertain, and may have been only young uredinia.

109. **Uredo fenestrala** sp. nov.

Uredinia hypophyllous, irregularly scattered, or occasionally in small groups, pustular, 0.1–.25 mm. across, opening by a central pore becoming enlarged and irregular, subepidermal; peridium hemispherical, delicate, cellular, the cells elongated more or less at the sides, nearly isodiametric above, trapezoid or cuboid, 10–13 μ long, the walls evenly thin, the ostiolar cells unmodified; urediniospores obovoid or ellipsoid, inclined toward pyriform, 16–22 by 25–36 μ; wall cinnamon-brown, slightly paler below, evenly thin, 1–1.5 μ, moderately echinulate, the pores indistinct, apparently 2 or 3, somewhat superequatorial.

ON EUPHORBIACEAE:

Phyllanthus grandifolius L., Bayamon, Feb. 19, *389*, May 21, *1822* (type); Villa Alba, Jan. 4, *527*.

The rust on the same host has also been detected on a phanerogamic specimen, collected on the island of St. Domingo, Dec. 1909, N. Taylor *365*.

What appears to be the same rust showing only uredinia was collected on *Phyllanthus distichus* (L.) Mull.-Arg., San Juan, P. R., January, 1911, by E. W. D. Holway. The texture of the leaf is less firm in this host, and the rim of the sorus does not hold up sufficiently to give the crater-form appearance usually seen on *P. grandifolius*. The urediniospores are also slightly smaller and paler.

The peridium in this species is most delicate and difficult to demonstrate from dried specimens. The usual appearance in free-hand sections is that of a sorus without enveloping structures; there certainly are no paraphyses. The description of *Uredo Phyllanthi* P. Henn. from Brazil, gives the wall of the spore as smooth and 2–3 μ thick. The uredinia of *Phakopsora Phyllanthi* Diet., which occurs on *Phyllanthus distichus* in India and the Philippines, is said to have strongly developed, incurved paraphyses. The descriptions only of these two species are available to the writer, and they indicate decidedly unlike forms, both of them differing from that in the West Indies.

(To be continued)

SOME PORTO RICAN PARASITIC FUNGI

Philip Garman

(With Plate 171, Containing 7 Figures)

The following descriptions and notes have been made upon Porto Rican fungi collected by Dr. F. L. Stevens during the years 1912 and 1913. A description of the material contained in this collection has already been given in a paper by Miss Esther Young.[1] The types and cotypes of new species have also been distributed as set forth in that article.

Thanks are due to Dr. F. L. Stevens for his many helpful suggestions, without which the work would not have been possible. The species of hosts, with few exceptions, have been determined by Dr. N. L. Britton and Mr. Percy Wilson, of the New York Botanical Garden, and to them also I wish to express my thanks.

Septoria Fries

1. **Septoria Petitiae** sp. nov.

Spots 1–2 mm. in diameter, suborbicular, with a white center and a brownish or fuscous margin; perithecia about 0.1 mm. in diameter, black, two or three to a spot; spores slightly curved, hyaline, 2-guttulate, $16–46 \times 1.2\,\mu$. (*Pl. 171, f. 1.*)

On leaves of *Petitia domingensis* Jacq. in Porto Rico: Cabo Rojo, *6470* (type), *9756*.

2. **Septoria Miconiae** sp. nov.

Spots about 1.2 mm. in diameter, circular, with a white center and a brown and distinctly elevated margin; perithecia $50\,\mu$ in diameter, black, immersed; ostiole $24–48\,\mu$ in diameter; spores three- to many-guttulate, usually curved and hyaline, $19–26 \times 2\,\mu$. (*Pl. 171, f. 2.*)

On leaves of *Miconia laevigata* DC. in Porto Rico: Las Marias, *117*, *357* (type), *369*.

[1] Mycologia, 7: 143–150. 1915.

3. **Septoria Guettardae** sp. nov.

Spots large, 4–5 mm. or more in diameter; margin irregular and dark-red, the center of the spot becoming white and contrasting strongly with the remainder of the leaf; perithecia black, 50 μ in diameter; ostiole about 24 μ in diameter; spores curved, hyaline, many-guttulate, 28–38 × 2.4 μ. (*Pl. 171, f. 3.*)

On leaves of *Guettarda ovalifolia* Urb. in Porto Rico: Monte Alegrillo, *9759* (type).

4. **Septoria Lantanae** sp. nov.

Spots varying from 1–2 mm. in diameter, somewhat irregular in outline, sooty; perithecia 76–96 μ in diameter; ostiole indefinite, about 40–60 μ in diameter; spores long, slightly curved or straight, several-septate, 24–50 × 2.4 μ. (*Pl. 171, f. 4.*)

On leaves of *Lantana camara* L. in Porto Rico: *221x* (type).

This species differs decidedly from *S. Verbenae* in the character of the leaf spot which lacks the white center.

5. **Septoria Pityrogrammae** sp. nov.

Spots brown, indefinite; perithecia 96 μ in diameter, black; ostiole 20–30 μ in diameter; spores long and thread-like, 3–4-spetate, sometimes apparently continuous, hyaline, curved and acute at both ends, 40–60 × 2.4 μ.

On leaves of *Pityrogramma calomelanos* L. Indiera Frios, Maricao, *3484* (type).

This species is near *S. aquilina* Passer, from which it differs mainly in spore characters, the spores of this species being distinctly curved, acute at both ends and only one-half the diameter of the species *S. aquilina* on *Pteris*.

6. SEPTORIA ASIATICA Speg. Fungi Chilenses 168. 1910

On leaves of *Centella asiatica* Urb. in Porto Rico: Vega Baja, Santurca San Sebastian, *265, 4231, 5207*.

7. SEPTORIA CHELIDONII Desm. Ann. Sci. Nat. II. **17**: 110. 1842

On leaves of *Argemone mexicana* L. in Porto Rico: Guayama, *5398*.

In the following descriptions of the genera related to *Dimerosporium* and originally included under this head by Saccardo, the work of Thiessen[2] has been followed rather closely. Several species commonly known as *Parodiella* seem to fall within the limits of this classification, and have been moved to what appears to be a more natural position within the "Dimerineae."

DIMERIUM Sacc. & Syd.

1. **Dimerium Cayaponiae** sp. nov.

Spots black, sooty, epiphyllous and irregular in outline, never more than 3 mm. in diameter; perithecia black, globose, 0.12 mm. in diameter; asci linear-clavate, eight-spored, $33.6–36 \times 2.4 \mu$; spores two-celled, dark, smoky, one cell considerably smaller than the other, $7.3–9.6 \times 3.6–5 \mu$. (*Pl. 171, f. 5.*)

On leaves of *Cayaponia americana* (Lam.) Cogn. in Porto Rico: Utuado, *4360* (type).

The dark, black spot is characteristic of the species. This is formed partly of discolored host tissue and partly of a dense compact fungous mycelium.

2. **Dimerium grammodes** (Kuntze) comb. nov.

Dothidea perisporioides Berk. & Curt. Grevillea 4: 103. 1876.
Sphaeria perisporioides Berk. & Curt. Grevillea 4: 102, 107. 1876.
Dothidella grammodes Sacc. Syll. Fung. 2: 634. 1883.
Dothidea grammodes Berk. Jour. Linn. Soc. 10: 341. 1869.
Dothidea seminata Berk. & Rav. Grevillea 4: 104. 1876.

On leaves of *Crotalaria retusa* L., *Phaseolus lunatus* L., *Meibomia adscendens* O. Kuntze, and an undetermined legume belonging to the Papilionaceae, in Porto Rico: Maunabo. Papilionaceae, *2452;* Utuado, *4418;* Aguadilla, *Phaseolus lunatus, 5027;* Guayama, Cabo Rojo, *Crotalaria retusa, 5333, 6480;* Rio Piedras, *Meibomia adscendens, 5723.*

This pretty and widespread species occurs, as can be seen from the above, on a variety of leguminous hosts in Porto Rico. It does not differ essentially from the descriptions of the species from other parts of the world. The specific name *grammodes*

[2] Zur Revision der Gattung Dimerosporium. Botanische Centralblatt 29: pt. 2; 45–73. 1912.

has been used recently by Rehm; *perisporioides* being the most frequently used up to that time. The original works of Kuntze, containing descriptions or exsiccati have not been available, and the change is herewith accepted solely upon the authority of Rehm. The fungus is placed in *Dimerium* because it offers no striking differences from other members of that genus.

3. **Dimerium melioloides** (Berk. & Curt.) comb. nov.

Parodiella melioloides Winter, Hedwigia **24**: 257. 1885.
Dimerosporium lateritium Speg. Fungi Puiggariani Pug. **1**: 110. 1889.

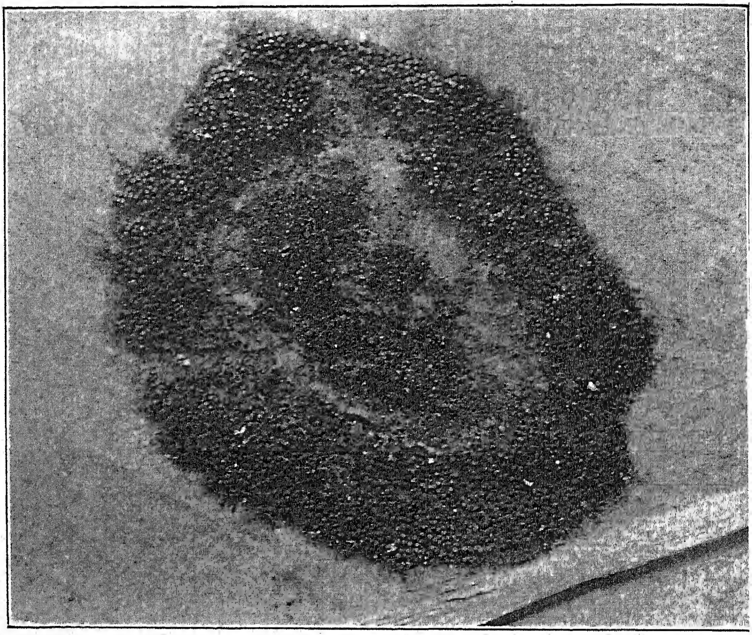


FIG. 1. *Dimerium melioloides,* showing concentric arrangement of perithecia.

Sphaeria melioloides Berk. & Curt. Jour. Linn. Soc. **10**: 387. 1869.
Rosellinia melioloides Sacc. Syll. Fung. **1**: 276. 1882.
Nectria megalospora Sacc. & Berl. Rev. Myc. **7**: 157. 1885.

On leaves of *Clusia rosea* Jacq. in Porto Rico: Maricao *285a, 816, 946, 3615.*

The species is referred to the genus *Dimerium* and differs from the usual form occurring in *D. grammodes* in the possession of a compact, radiate mycelium on the surface of the leaf. The species *D. melioloides* has been placed in the genus *Parodiella* by Rabenhorst and Winter, and distributed in their exsiccati under that name, but there is some uncertainty as to its real position as shown by the location originally given it by Saccardo.[3] The majority of the material at hand possesses spores that are only feebly colored, together with a few dark spores, but the large amount of material examined would seem to indicate that the dark spores occur only occasionally.

4. **Dimerium Stevensii** sp. nov.

Spots irregular in outline, one to several mm. in diameter; perithecia sperical, black, shining, 100 μ in diameter; asci clavate, 42–50 $\times$ 20–22 μ; spores slightly greenish-hyaline, sometimes dark, two-celled, 16–20 $\times$ 6–8 μ; paraphases abundant.

On leaves of *Cordia corymbosa* (L.) G. Don. Quebradillos, "College Grounds," Mayaguez, *934* (type); Maricao *4816*.

DIMERINA Thiessen

1. **Dimerina Jacquiniae** sp. nov.

Spots small, 0.25 μ in diameter, composed of a number of black, spherical perithecia, usually about 10; mycelium scant, loose, slightly reddish; perithecia black, 48–60 μ in diameter; asci hyaline, ovate, 26.4 $\times$ 12 μ; spores slender and hyaline, 14.4–17 $\times$ 3.6 μ.

On leaves of *Jacquinia barbasco* (Loefl.) Mez. Mona Island, *6087* (type).

PHYLLACHORA Nitschke

1. PHYLLACHORA PERIBEBUYENIS Speg. Rev. Myc. 9: 95. 1887

On leaves of the Melastomataceae, especially *Miconia prasina* DC., *M. laevigata* DC., *M. Sintensii* Cogn., *Heterotrichum cymosum* Urb., and a species of *Tetrazygia*: in Porto Rico: Maricao, Consumo, Las Marias, *166, 741, 840, 1355a, 4708; Miconia laevi-*

[3] Saccardo: Sylloge Fungorum 1: 276.

gata: Villa Alba, Maricao, Rosario, *84, 162, 163, 171, 742a, 4813; Miconia* sp., Monte Alegrillo, *1355; Miconia Sintensii,* St. Ana, *6656; Tetrazygia* sp., Jayuga, *500; Heterotrichum cymosum,* Indiera Fria (Maricao), Manati, Ponce, Utuado, Maricao, Quebradillas, San Sebastian, Luquillo Forest, Jajome Alto, Gigantà near Adjunta, Prestons Ranch, Dos Bocas, *3372, 4326, 4374, 4380a, 4391, 4392, 4705, 4984, 5206, 5595, 5652, 5941, 6779, 6859;* on various Melastomataceae.

This exceedingly common species in Porto Rico is undoubtedly Spegazzini's *P. peribebuyensis,* as shown by a comparison with exsiccati of Roumeguere (Fungi Gallici Exsiccati *3234*). Its systematic position becomes doubtful, however, when we examine the character of the stroma and its attachment to the leaf. No species of *Phyllachora* have been described which possess the central stroma attachment (see *fig. 7*) that this species possesses, and the more common species of *Phyllachora* such as *P. graminis* differ so much from this type both in the shape and relative position of the stroma that it would seem advisable to make this and other species of the same nature into a new genus. In Saccardo's description of *peribebuyensis,* he questions the true position of the fungus and states that it is closely related to, though different from, *Bagnisiella,* a closely allied form. His generic description also contains the statement that many forms have been collected under the genus name *Phyllachora,* which properly belong elsewhere. In keying the species out through the analytical tables offered by Saccardo and Lindau in Engler and Prantl, the species falls into *Bagnisiella* and seems to be totally excluded from *Phyllachora* by the nature of the stroma. Saccardo, however, states that *peribebuyensis* is different from anything in *Bagnisiella,* and judging from descriptions and figures of *Bagnisiella,* this is correct. Considering the character of the stroma alone, then, the erection of a new genus would seem to be necessary. Recent authors are, on the other hand, inclined to disregard stromal characteristics and to found classifications on more fundamental bases. The species has, therefore, been left in its original position because it is not different in other respects from typical species of *Phyllachora.*

2. **Phyllachora nitens** sp. nov.

Stroma forming a large black shining spot, often covering an area as much as 1 cm. in diameter; asci clavate, eight-spored, $100–110 \times 12–16\,\mu$; spores mostly ovate, somewhat acute at one end, hyaline and slightly granular; $6–8 \times 10–12\,\mu$; paraphases present.

On leaves of *Schlegelia brachyantha* Guseb.; in Porto Rico: Maricao, *873* (type), *857;* Ponce, *4352;* Monte Alegrillo, *4501;* Rio Grande, *4502;* Prestons Ranch, *6776.*

3. PHYLLACHORA RENALMIAE Rehm, Hedwigia 36: 373. 1897

On leaves of *Alpinia antillarum* R. & S., in Porto Rico: Maricao, Monte Alegrillo, *805, 2344.*

The following collections possess the typical stroma but lack asci and ascospores: Maricao, *192, 705;* Rio Maricao, *3606;* Utuado, *4385a;* Jajome Alto, *5654;* Yunque, *2385;* Monte Alegrillo, *4749.*

4. PHYLLACHORA SPHAEROSPERMA Winter, Hedwigia 23: 170. 1884

On leaves of *Cenchrus echinatus* L. and *C. myosuroides* H.B.K.

Vega Baja, *1730, C. echinatus;* Mona Islands, *6330, C, myosuroides.*

5. PHYLLACHORA GRAMINIS (Pers.) Fuckel, Symb. Myc. 218. 1869

On leaves of *Panicum, Andropogon brevifolius* L., *Lasiacis Swartziana* Hetche, and a species of *Paspalum,* in Porto Rico: Luquillo Forest, *4527, Panicum;* Maricao, *168,* Rio Piedras, *5751, Andropogon brevifolius* L.; Jajome Alto, *5657, Lasiacus Swartziana* Hetche; Sabana Grande, *317, Paspalum.*

6. PHYLLACHORA ANDROPOGONIS (Schw.) Karst. & Har. Rev. Myc. 12: 172. 1890

On leaves of *Paspalum Underwoodii* Nash, in Porto Rico: Prestons Ranch, *6763.*

The species differs from *P. graminis* in spore size, which

character seems to be fairly constant. In *P. graminis,* however, there is some variation and it would seem as though the species described under that name would also include the variety "*tupi*" of Spegazzini. The divergence in this case from the typical *P. graminis* is sufficient, I think, to warrant the maintainance of the species name *Andropogonis.*

7. PHYLLACHORA PERFORANS (Rehm) Sacc. & Syd. Hedwigia 39: 232, *fig. 4.* 1900

P. paulensis Rehm, Ascom. Exc. 1747. 1907, Ann. Myc. 471. 1907.

P. dalbergiicola Henn. var. *perforans.* Rehm, Hedwigia **1906**: 232. *fig. 4.*

On leaves of *Abrus precatorius* L. in Porto Rico: Mayagüez, *313, 1196.*

AUERSWALDIA Sacc.

AUERSWALDIA PALMICOLA Speg. Fungi. Guar. Pug. **1**: 121. 1883.

On leaves and petioles of *Ascrista monticola* Cook. Adjuntas, El Gigante, *6065.*

This fungus agrees in all features with the description given by Saccardo. In the specimens at hand, very little coloration occurs in the spores. Comparisons with exsiccati (Roum. Fungi Gall. *4067*), however, show that the form is without doubt *Auerswaldia.*

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EXPLANATION OF PLATE CLXXI

Fig. 1. *Septoria Peititiae* sp. nov. a. Leaf, showing spots. × ½. *b.* Spot, slightly enlarged, showing pycnidia. *c.* Spores × 200.

Fig. 2. *Septoria Miconiae* sp. nov. *a.* Leaf, showing spots. × ½. *b.* Spot enlarged about 12 diameters. *c.* Spores × 480.

Fig. 3. *Septoria Guettardae* sp. nov. *a.* Leaf with spots. × ½. *b.* Spot, enlarged. *c.* Spores × 275.

Fig. 4. *Septoria Lantanae* sp. nov. *a.* Leaf with spots. × ½. *b.* Spores × 500.

Fig. 5. *Dimerium Cayaponiae* sp. nov., showing pycnidia, asci and ascospores, much enlarged.

Fig. 6. *Dimerium melioloides,* asci and spores, enlarged.

Fig. 7. *Phyllachora peribebuyensis,* cross section of stroma (left) and group of asci, all much enlarged.

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